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THE ITALIAN IRONCLAD DANDOLO.

THE new twin-screw, double-turret vessel Dandolo, belonging to the Royal Italian Navy, has just completed the trials of the machinery previous to joining the squadron in the Mediterranean. Excepting the omission of the internal torpedo deck, she resembles the sister ship, Duilio, in her general arrangement, but she has considerably surpassed her in speed. The Dandolo was built at the Royal Naval Arsenal at Spezia, under the supervision of Director Borghi, at whose suggestion the whole of the bow plating is worked flush, instead of the plates overlapping as usual. The length of the vessel is 337 ft. 8 in.; the breadth 62 ft. 3½ in.; the mean draught at the trials with armament on board was 28 ft. 9 in.; giving a total displacement of 11,225 tons. The battery is heavily armored, and is placed in the middle of the vessel; the two turrets rise above the weather deck, and are placed diagonally in the battery, so as to enable all four guns to be fired fore and aft. The armor of the turrets is impenetrable to all except the heaviest modern artillery. Each turret contains two 100-ton Armstrong guns made at Elswick, having a bore 17·72 inches, throwing a shot 2,018 lb. with a *maximum* of 511 lb. of powder, the ordinary charge being 355 lb. The turrets and guns are moved and worked by a complete system of hydraulic gear made at Elswick. The loading is also done by the same means, the rammers being below the weather deck and arranged to enter the gun when the muzzles are depressed for the purpose. Between the turrets is situated the mast, which really assumes the function of a lookout tower, as there are no sails.

The vessel is fitted with Forrester's steam steering gear, as well as very powerful hand steering gear, and has a beautiful self-acting arrangement, designed and fitted by the Italian constructors, for checking and holding the tiller; in case of the chains breaking the tiller would lock itself amidships and remain at rest till the new chain was reeved.

The Dandolo carries four large steam launches, and eight other boats, all hung upon hinged davits which are worked from the steam capstan, and which will hoist them right in board. The Dandolo is propelled by twin screws, worked by two independent pairs of engines, which were contracted to indicate a *maximum* power of 7,500 horses. These engines, together with the pumping and blowing engines, were constructed by Messrs. Maudslay, Sons & Field, of London. They are the first compound engines which were ordered for the Royal Italian Marine, though they have been awaiting the completion of the ship at Spezia since 1876, when they were brought out in the royal transport Europa. Each set of engines is placed in a separate water-tight compartment, one at each side of the vessel; instead of being side by side they are situate one in advance of the other, the alternate spaces being occupied by the magazines, which are placed immediately below the turrets. Each pair of engines has one high pressure cylinder, 64 in. in diameter, and one low pressure, 120 in. diameter, with a stroke of 4 ft. Steam of 65 lb. pressure is supplied by eight large oval and double-ended boilers, having 32 furnaces in all. Four boilers are placed forward of the engines, and the other four aft; but each pair of boilers is contained in a separate water-tight compartment. The chimneys, which are ample in size and height, are built of one-inch plate from the main deck to the flying deck above the turrets, so as to enable them to withstand the great shock produced by the discharge of the guns.

A very perfect system of fans and ventilating pipes has been carried out, so that the whole of the cabins and even the engine room are kept perfectly sweet and fresh. There is also another arrangement for ventilation very closely resembling in principle the furnace system of ventilation in a mine.

On the 25th of May the Dandolo proceeded to sea for her first official trial, under the command of Commandante E. Acton, who was accompanied by Admirals Martin-Franklin and Caimi. The run to Genoa and back was accomplished without stopping in 6 hours and 28 minutes, with a mean indicated horse power of nearly 7,200, and a maximum of 7,415 horses, and the speed obtained was 15¼ knots, with a consumption of 51¼ tons of coal. The main object of the run was to ascertain the consumption of fuel on a prolonged full-power run. On the 29th of May the vessel was taken on the measured knot trial, when a speed of 15·55 knots was obtained with 8,050 horse-power.

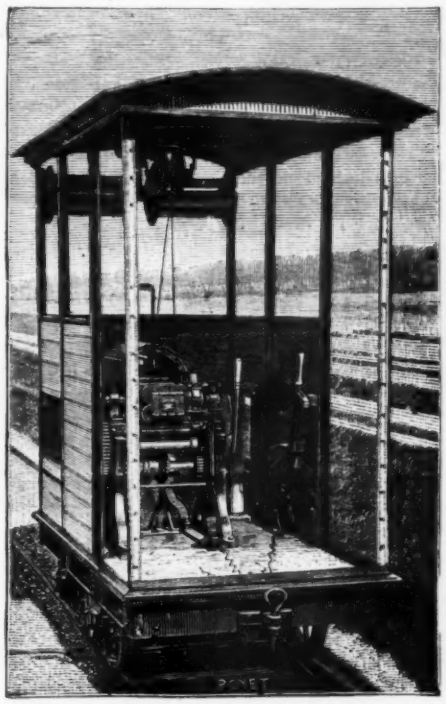


FIG. 1.—LOCOMOTIVE OF THE ELECTRIC RAILWAY.

FIG. 2.—TENDER DETACHED FROM THE LOCOMOTIVE. (Front End View.)

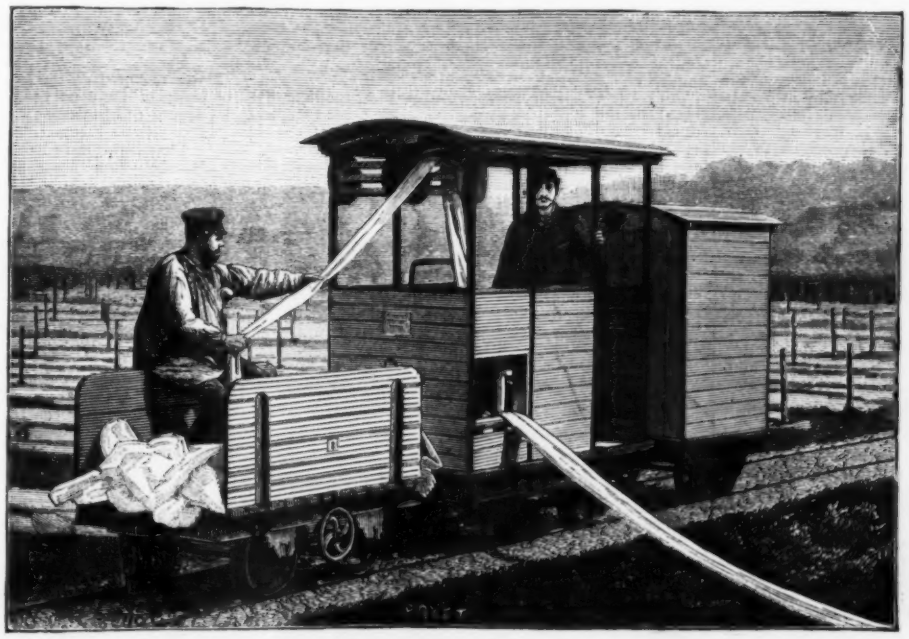


FIG. 3.—THE MOTOR ACTUATING THE ROLLERS THAT TAKE UP THE GOODS.

AN ELECTRIC RAILWAY OPERATED BY SECONDARY BATTERIES.

AN ELECTRIC RAILWAY ACTUATED BY ACCUMULATORS.

AN industrial application of electricity of considerable importance has just been made in a large bleaching works of the Department of Calvados, France, and consists in the establishment of a railway operated by accumulators.

The linen bleaching works of Mr. Paul Duchesne Fournet, whose directing engineer is Mr. Clovis Dupuy, is situated at Le Breuil-en-Auge. It is a large establishment, where the brown fabrics, manufactured at Lisieux, are treated, in order to bleach them, with chlorine and alkaline solutions, and by exposure to sunlight. The action of the sun is obtained in the open air in large fields, over which the pieces of linen are spread. Each piece of goods is 100 meters in length; and there are 15 hectoliters of ground which may thus be covered. The operation of gathering up the pieces takes a long time, and requires the labor of several workmen. It occurred to Mr. Dupuy that this operation might be performed by means of a railway carrying a special mechanism. But, as steam cars could not be used in a bleaching works, owing to the fact that the smoke and cinders would soil or burn the goods spread out over the grass, the skilled engineer resolved to build an electric railway. This he has done, and the whole affair is now operating very advantageously.

The track of the railway passes in front of all the lines of goods, over an extent of about 2,040 meters, 500 meters of it being straight, and there being twenty-one branches. The track is a narrow gauge, (0·80 meter), and the rails are of the Vignole type.

The trains, which are moved by a dynamo-electric machine (Fig. 1), actuated by Faure accumulators (Fig. 2), leaves the work with its cars empty. Having arrived on the ground, it stops, and the motor is made to actuate pick-up rollers between which is fastened the end of the piece to be gathered in. The cloth, as it leaves the rollers, passes over a reel and is deposited in the car by a workman (Fig. 3). As all the pieces spread out on the grass have previously been connected, end to end, one man can take up 5,000 meters in 30 minutes, although by ordinary methods this would take 11 hours.

Fig. 4 shows the train just as it has arrived at the works with its load of 10 000 meters of goods.

The motor, or locomotive (Fig. 1), consists of a reversible Siemens machine of 120 kilogrammeters power. A diminution of speed in the ratio of 1 to 9 is obtained by an endless chain transmission. The machine is controlled by a maneuvering lever (Figs. 1 and 5). In the vertical position in which this is shown in Fig. 5 the brake is unlocked, and no electrical action takes place. On depressing the lever an electric contact is set up, the rheostat chain becomes tauter and tauter, and the rings touch each other better, thus diminishing the electrical resistance and increasing the speed.* The speed of the train then varies according as the lever is pushed in one direction or the other. When it is in its position of rest it locks the brake at the same time. There is a second lever, which is arranged for reversing the direction, by acting upon the

* The rheostat chain was invented by M. E. Reynier, who applied it last year to a sewing-machine operating at the Paris Exhibition of Electricity.

brushes of the dynamo-electric machine; and a third, which permits of connecting the motor either with the motive axle to move the train or with the rollers to gather up the goods.

The tender (Fig. 2) contains the Faure accumulators (large size) constructed by Mr. Reynier. These are arranged in three tiers in baskets, each containing six of the apparatus. Two of the tiers contain four baskets, and the other contains two. The sixty accumulators weigh 500 kilogrammes.* These accumulators are charged by a current from the Gramme machine, which has been used for lighting the works since 1879, by means of eleven Reynier lamps. The

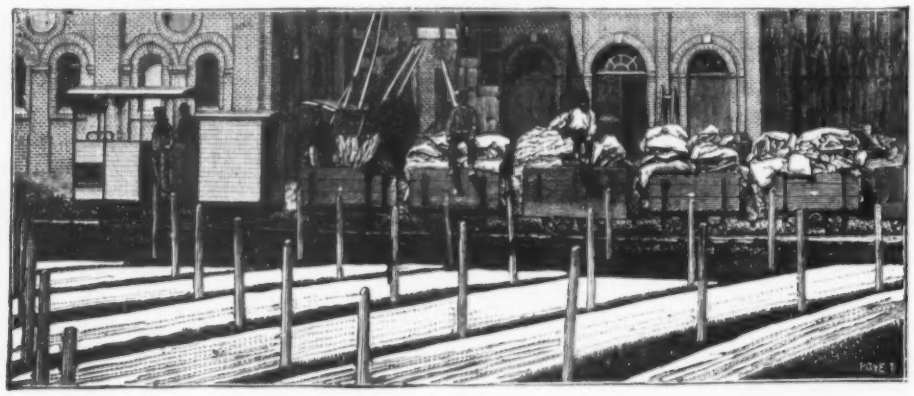


FIG. 4.—ARRIVAL OF THE LOADED TRAIN AT THE WORKS.

works are capable of producing a 60-horse motive power. Of this only three is utilized during the time of charging, which lasts from five to eight hours.

At the upper end of the tender there is a commutator (Fig. 2) which admits of setting the accumulators successively in operation—first, to the minimum number of twenty-four, and then, by a successive increase of six, up to sixty.

The railway has now been in operation for six weeks, and has proved in every way advantageous and convenient. The speed of the train is 12 kilometers per hour; but in this special application rapidity has in no wise been sought. The

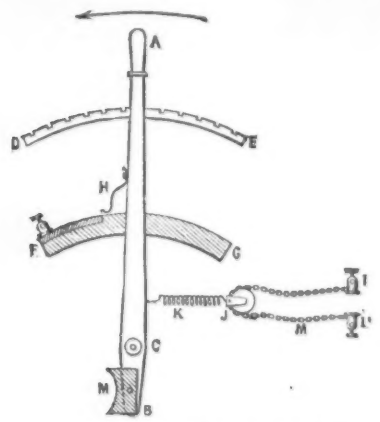


FIG. 5.—MANEUVERING LEVER.

A, B, C, Ratchet lever working between the two arms of the sector, D, E. F, G, Wooden sector carrying two contact plates into which the current enters. H, Elastic rubber for forming a contact. I, J, I', Rheostat chain passing over the roller, J, which is connected with the lever by a spring, K. M, Brake block. C, Lever joint.

duration of working, according to Mr. Dupuy, is three hours, and this is limited by the charge of the conductors.

If such a system were employed for carrying passengers on tramways, all that part of the apparatus which serves for gathering up the goods would give way to accumulators, thus permitting of the tender being dispensed with.

NEW IMPROVEMENTS IN ELECTRIC PILES.

THE *formation* of Faure accumulators is effected in our shops by means of a very constant and relatively economical pile, whose arrangement has been studied with a view to obtaining the following triple result: continuity in the discharge of electricity, absence of emanations, and simplicity of performance. This pile consists of zinc copper couples depolarized by sulphate of copper. It owes its special qualities to the use of *narrowly partitioned zincs*. The partitioning off of the negative electrodes is, moreover, applicable to the majority of known voltaic combinations. We had proposed to wait, before making this process known, until an application had been made of it in other couples, such as zinc-copper acidulated water, zinc-carbon-chromic mixture, zinc-carbon-nitric mixture, etc. We might then have been able to present a general work on the properties of narrowly partitioned negative electrodes, and on their general application; but the results furnished by our sulphate of copper pile, during the three months that it has been operating, have brought us orders for it which we have had to fill at once. Having thus distributed and put in service more than five hundred couples, it is scarcely possible for us to defer a description of them any longer, and we have decided to speak of them, although the application of our process to other voltaic combinations will be reserved for another occasion.

Let us consider an ordinary Daniell couple: zinc, sulphate of zinc—copper, sulphate of copper. The chemical reactions as a whole that take place in this pile end in a transformation of sulphate of copper into sulphate of zinc, with a solution of the zinc and a deposit of metallic copper.

Why do we separate the two liquids? Simply to attenuate the local action of the zinc on the sulphate of copper, an action which uselessly uses up the zinc and the sulphate of

* The weight of the locomotive is 935 kilogrammes; that of the tender is 700; and each car, when loaded, 800. With the workmen and six passengers, the total weight of the train is 6,400 kilogrammes.

the couple. Owing to the porous partition, the local action of the zinc is not exerted upon the mass of the sulphate of copper contained in the pile, but only upon the quantity of this salt which gradually diffuses itself through the diaphragm.

The quantity of sulphate of copper that passes from the zinc side depends principally upon the nature of the diaphragm and its superficies, and scarcely upon the capacity of the zinc compartment. Then, if such capacity were very small, the prejudicial local action would be rather diminished, since there would be a diminution of surface.

Would there not, then, supervene a detrimental concentration of the sulphate of zinc toward the negative electrode? No, because the sulphate of zinc, which is extremely soluble, diffuses itself very quickly outside, and the electric current aids such action by effecting a very marked transference from the negative to the positive in the interior of the couple.

Experiment, which confirms these provisions, demonstrates that, in fact, the porous vase which contains the zinc may be reduced in width till it rests closely against the latter. This very narrow vessel, which we call a *partitioning*, may be made in the same way as our former prismatic porous vessels, the form and the explanation of which may be found in *La Lumière Electrique*, vol. ii., p. 289. 1880. The accompanying Fig. 2 represents a zinc very closely confined within a "partition" of parchment paper. In order to protect the paper we cover it with a thin fabric, which only offers to the passage of the current an additional resistance that is scarcely measurable.

On immersing a zinc thus prepared in a copper vessel containing a solution of sulphate of copper, we obtain a constant couple which has but a feeble resistance. The sulphate of copper slowly traverses the permeable sides, and, on coming in contact with the zinc, becomes transformed into sulphate of zinc, with a precipitation of copper This action being more rapid than the phenomenon of osmosis, the small quantity of liquid contiguous to the zinc soon becomes reduced to sulphate of zinc. We then realize the conditions of an ordinary Daniell pile of very small resistance, but with the advantage that the couple, although containing two well separated liquids, necessitates practically the manipulation of but one. When the sulphate of copper is used up, we renew in fact only the external liquid. The small quantity of liquid contiguous to the zinc remains inclosed with the latter, ready to diffuse, in the renewed solution of copper sulphate, the excess of zinc sulphate which will finally form. There is then no zinc sulphate to be put in or taken out. Finally, the renewal of the sulphate of copper has been simplified by an arrangement which will be understood at a glance by reference to Fig. 1.

The copper trough, which performs the functions of positive electrode, is provided in front with a pipe carrying a rubber tube. This latter, when elevated, holds the liquid back; but, when disengaged from its retaining hook, and lowered, it allows the used-up liquid to flow out into a copper gutter extending along the whole length of the pile. When the emptying has been effected, the tube is again raised, the trough is filled with ordinary water, and a proper quantity of copper sulphate is put into the small wicker basket, P, (Fig. 1), which is hooked to the upper part of each trough. The solution takes place spontaneously.

We should remark that, in these couples, there are no earthen vessels, and for this reason the piles may be constructed of any desired shape and dimensions. We have manufactured some that had a capacity of thirty liters (about 6½ gallons), and which used effectively a kilogramme (2¼ lb.) of zinc per day. But we might go even beyond that.

The dimensions of the zinc in the couple shown are:

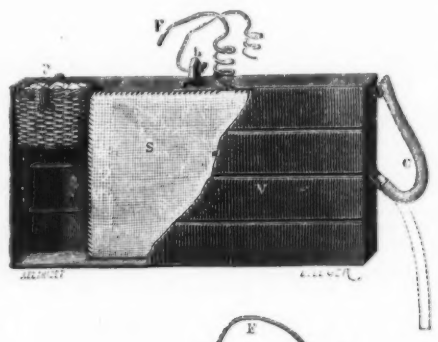
Length	333 millimeters.
Width	160 "

Those of the trough are:

Length	450 millimeters.
Width	50 "
Height	220 "

The internal resistance of a couple of this size is 0·2 ohm, which may be diminished by the daily addition of a small proportion of a *conducting mixture*, composed of several

FIG. 1.



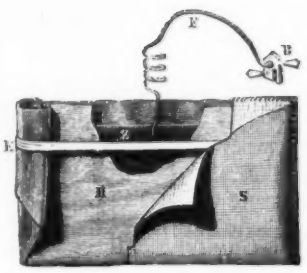


FIG. 2

neutral or acid salts, selected from among those which conduct the best, which are most soluble and cost least. Each may be composed in its way of a similar mixture. That which we use has the following composition:

Chloride of potassium	200
Chloride of sodium	400
Sulphate of potassa	200
Sulphate of soda	400
Sulphate of zinc	50
Sulphate of ammonia	100
Bisulphate of soda	200

This inexpensive addition reduces the internal resistance of the couple to 0·14 ohm, thus raising its *maximum external work* to 0·2 kilogrammeter per second.

The pipe is placed so high up as to allow the passage of only about a third of the external liquid. We thus retain two-thirds of the sulphate of zinc and conducting salts of the copper compartment; so that the couple, when charged, enters again into active operation.

The operation of the pile is interrupted but once a month, for about four hours, in order to renew the zincs and to remove the deposit of copper. From this continuity of

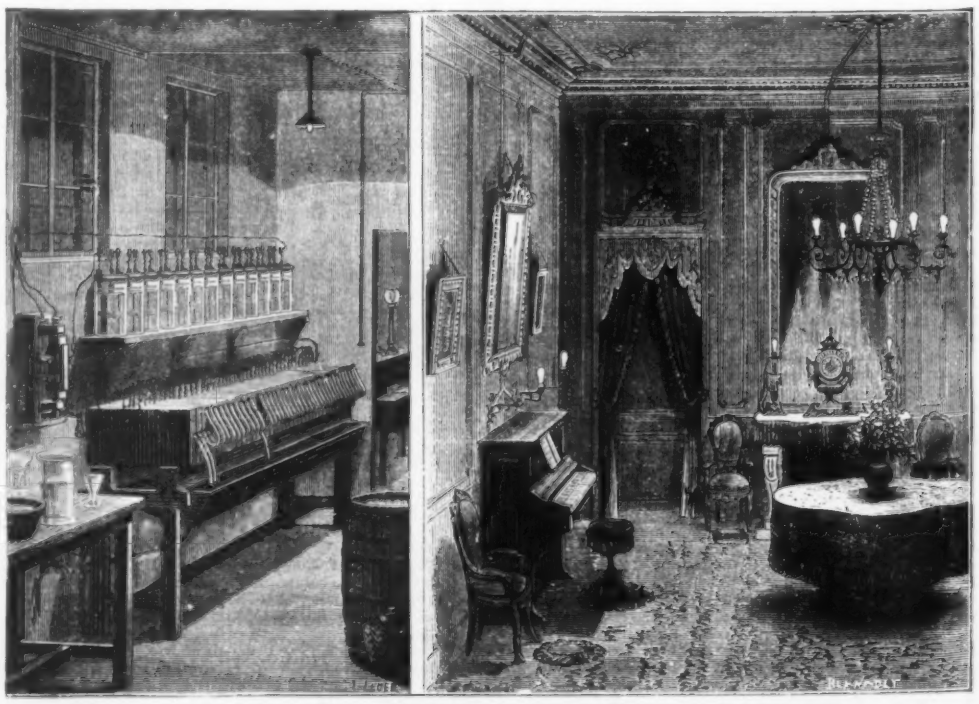


FIG. 3.—ARRANGEMENT OF PRIMARY AND SECONDARY PILES FOR LIGHTING BY INCANDESCENCE.

action there results a daily sum of work which is relatively great, and which might be accumulated in secondary piles during the hours in which the electricity is not being used.

The copper taken from the pile will be in demand at a high price among several industries, especially that of electric cable manufacturing. The expense of the pile, then, is reduced to the price of the sulphate of copper. It will be seen presently that this expense is sufficiently moderate to allow the pile hereafter to be applied for different purposes, such as the continuous and regular production of electricity for continued and accurate experiments, the electro-metallurgy of precious metals, the *formation** of accumulators, as a motive power for sewing machines, for electric lighting, etc. The following are a few data obtained from a pile which is in operation in *forming* a portion of the Faure accumulators constructed at our works:

PHYSICAL DATA.

Number of couples in the pile.... 68
Work that it effects: formation of eighteen large size Faure accumulators arranged for tension 18

Electromotive force of the pile:
1·07 volt x 68 ....72·7 volts.
Electromotive force of the accumulators:
2·2 volt x 18..... .....39 "
Excess: 72·7—39 ....33 "

Resistance of the primary pile:
0·14 ohm x 68 .... 9·52 ohms.

Resistance of the secondary pile:
0·02 ohm. x 18 .... 0·36 "
Intensity of the current: 33:9·88.....3·34 amp.

Total work in kilogrammeters per second:
3·34 x 72:9·81..... .. 24 51 kgms

Work confined in the primary pile:
3·34² x 9·52:9·81..... .....11·24 "
Work external to the primary pile.....13·27 "

ECONOMIC DATA.

Space occupied by the primary pile:
Length..... 3·90 meters.
Width..... .....0·60 meter.
Height..... .....0·30 "
Quantity of water to be renewed per twenty-four hours: say one liter per couple..... .. ..68 liters.
Sulphate of copper used: theoretically, 368 gr. per couple; practically, 400 gr., say 0·400 k. x 68 in twenty-four hours.... .. ..27·20 kilos.

Zinc used per twenty-four hours: theoretically, 96·2 gr. x 68=6·542 k.; practically..... .... 7 "

Copper to be removed: theoretically, 93·79 gr. x 68=6·378 k., say, deducting loss..... 6 "

Weight of the conducting mixture:
10 grammes per couple, say..... .... 0·70 "

The pile costs us, then, about sixteen francs per twenty-four hours, to produce, in sum, as much work as a machine consuming a power of one horse, and which would have to remain at rest during night and be subjected to accidental or other stoppages.

We hasten to add that several other economical features may soon be introduced: the use of impure sulphates of copper instead of electro-metallurgic sulphates; the substitution of zinc contaminated with foreign metals (such as that derived from the galvanization of iron)† for new zinc; and a better utilization of the deposited copper. The cost price might, under such circumstances, perhaps, be reduced as low as ten francs.

The expense, although less than that of any other pile, is nevertheless very high. Yet we are convinced that this battery will find applications, indeed it has already found them. Moreover, this expense of sixteen or ten francs for a work equivalent to that of a one horse-power steam-engine during twenty-four hours appears less excessive when we apply it for obtaining certain results that could not be reached by engines. Thus, in conjunction with accumulators in proper grouping, our sixty-eight couples might actuate at least twenty sewing machines for ten hours, even supposing the piles and machines scattered through twenty different houses. They might also well light twenty Edison lamps,‡ operating together for five hours.

In order to obtain the same quantity of light during the same time, it would be necessary to burn at least one hundred and twenty candles of sixteen to the kilogramme, costing altogether more than sixteen francs. Now stearine candles, which are much inferior in various ways to small electric foci, being in extended use, we may admit that incandescent lamps, even illuminated by piles, might be able to find a place in houses for the purpose of lighting on a large scale.

The artist has shown in Fig. 3 an installation of twelve incandescent lamps; and, in order to show the lighting and the source of electricity at the same time, it has been necessary to represent the pile-room alongside of the parlor, although usually they should be more widely separated.

A pile of forty couples charges twenty accumulators. The primary pile may be coupled all in tension, or in two parallel series of twenty couples each. The secondary pile is likewise disposed in such a way that it may be coupled in single or double series. During the charge, the primary pile, coupled for tension, is put in opposition to the secondary pile, coupled for quantity. In order to light lamps, we put, on the contrary, the two piles in tension, the primary being first arranged for quantity, and the secondary in a single series. Such maneuvers, which are apparently complicated, are easily executed by means of Planté commutators.

It should be well understood that we do not pretend to enter into a contest industrially with piles against machines. Our only concern is to state provisional results, which we soon hope to surpass; the object of our statements being to make known what the question of electric piles has now become in our hands.

While awaiting further progress, we believe that our piles are already acceptable, either as ordinary producers of electricity for amateurs, or as convenient and reliable electro-motors for the use of physicists. EMILE REYNIER.

* For forming Faure accumulators, we employ piles and machines concurrently. The *formation* by piles is better than that by machines. We speak now of *formation* only, and not of the *charge*.

† G. de Tromellin.

‡ Save verification of the expenditure of energy attributed to these lamps, of which we have not as yet been able to procure a single specimen.

ELECTRIC PILE FOR LABORATORIES AND APARTMENTS.*

IT will perhaps be remembered that we proposed, some two years ago, a zinc, soda—copper, and sulphate of copper couple. This pile, as energetic as those with nitric acid, was free from emanations, and required the handling of no acid. In order to render it applicable for domestic purposes, it remained for us to reduce its cost, and we expected to succeed in this by electrolytic regeneration of the residue; but the improvements introduced into the Planté accumulator by Mr. C. Faure came almost immediately to demonstrate that the solution of the problem of *regeneratory piles* lies in the secondary couples, the charge of the accumulators requiring no preliminary manipulation of residues. The question of primary piles remained none the less interesting from the standpoint of a convenient and independent production of the current; yet accumulators, in supplanting primary piles in their application to the *conveyance of energy*, lent them, as an offset, a new element of success, and that was the possibility of prolonging, beyond the hours of consumption, the production of electricity, in order to *accumulate* it, and to amplify the intensity of the electric power during the discharge. A pile of small delivery may thus, by working continuously for twenty-four hours, suffice for a more abundant discharge, but of less duration.

Certain voltaic combinations that were first thrown aside as being not sufficiently energetic, might then again be taken up; and in the first rank among these is the zinc couple (sulphate of zinc—copper and sulphate of copper), which is very constant, entirely odorless, and relatively economical.

This couple, which is generally known under the name of Daniell's pile, although its principle was announced by Becquerel, had formerly had applied to it, by Mr. F. Carré and Sir William Thomson, improvements that rendered its internal resistance very slight. It had been proved, then, already, that piles of this kind could, without exceeding acceptable dimensions, give quantitative effects; and they lacked but little to become, with the aid of accumulators, convenient producers of electricity for laboratories and for domestic purposes. This little that was lacking we have supplied by simplifying the service of the pile, and by diminishing to a certain degree its daily discharge. Fig 2, which shows the different parts of a couple, will allow a description of it to be easily understood.

The receptacle is of copper, and performs the functions of positive electrode. The zinc, which is of rectangular form, is surrounded by a porous vessel of parchment paper, formed in the same manner as those of our old pile, but narrower. This special porous vessel, which we call the "partitioning," is almost entirely filled by the zinc, and is protected by a thin linen cloth sewed above. A zinc thus arranged, and dipping into a solution of sulphate of copper, constitutes, with the sides of the receptacle, a constant couple of small resistance.

In the very narrow compartment that holds the zinc, sulphate of zinc forms at first by local action, at the expense of the electrode and of a small quantity of sulphate of copper which reaches it through the partition. The couple then, of itself, assumes its condition for operating normally. The excess of sulphate of zinc, which will at length be formed through the closing of the circuit, will diffuse itself through the external compartment. This osmotic action is sufficiently rapid, favored as it is by the great solubility of the salt, and by a phenomenon of transportation, from the negative to the positive in the interior of the couple, effected by the current itself. Thus the osmosis becomes energetic just when it is necessary that it should be.

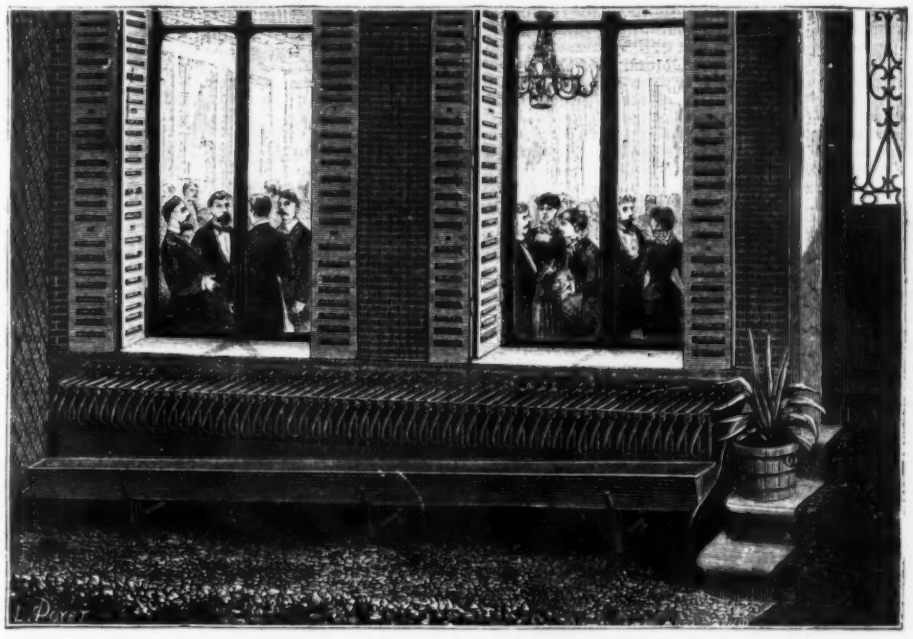


FIG. 1.—GENERAL VIEW OF SULPHATE OF COPPER PILES LOCATED IN FRONT OF A DWELLING HOUSE.

It is unnecessary then to pay any attention to the zinc compartment; and the service of the apparatus becomes practically that of a single liquid pile.*

Again, the renewal of the sulphate of copper is one of the simplest of matters. It consists in letting down the rubber tube with which each couple of the pile is provided, in order to allow a portion of the used-up liquid to flow out; in afterwards raising the said tubes to add common water; and in throwing into a wicker basket suspended from the upper part of the troughs a quantity of sulphate of copper which has previously been weighed out.

In order to diminish the internal resistance, there may be thrown into the couples a few grammes of a conducting mixture, composed of several neutral or acid salts, which are soluble and inexpensive, such as chlorides and sulphates of potassium and sodium, sulphate of ammonia, nitrate and bisulphate of soda, etc.

Once a month the pile is taken apart in order to change the zincs and to gather up the reduced copper which deposits in thick scales on the sides of the vessels, and from which it is easily detached by a wooden knife. This copper, which is free from metalloids, will be in demand at a high price, for the manufacture of conducting wires and certain alloys. Its sale naturally helps to reduce the general expense. There is nothing to limit us in the choice of the forms and dimensions to be given the receptacles and zincs. The latter, however, have to be bent or folded with their partitions, thus allowing of the surfaces in presence in a given vessel being multiplied, always as if it were a question of a single liquid pile.

The couples of our smallest models have the following dimensions: Length of zinc 0·333 of a meter; width, 0·16; length of trough, 0·44 of a meter; width, 0·05; height, 0·22.

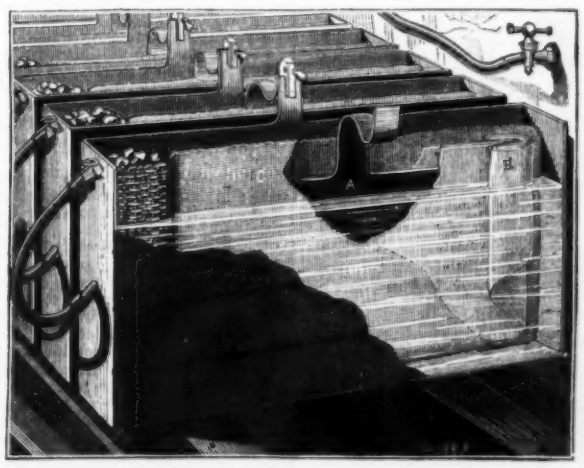


FIG. 2.—SECTION OF A REYNIER SULPHATE OF COPPER ELEMENT.
A, ZINC. B, PARCHMENT. C, LINEN CLOTH.

* Emile Reynier, in *La Nature*.

* We intend soon to take advantage of the properties of partitioned off negative electrodes in voltaic combinations other than the one under consideration.

The constants for this size are: E=1·07 volt; R=0·14 ohm.* The expense for twenty-four hours, for a work approximating maximum conditions is practically as follows: sulphate of copper, 0·4 of a kilogramme; zinc, about 0·1 kilogramme; with a production of about 0·09 kilogramme of copper. We have put in service at our residence a pile of sixty-eight small couples; and this is shown in Fig. 1, in the place that it occupies under the windows of the drawing room, in a small court yard, two meters wide, which separates the house from the street. This pile is alternately employed in the *formation* of Faure accumulators, in laboratory operations, and in lighting our residence.

In the formation of accumulators it shows itself superior to machines as regards the quality of the work obtained.†

For the laboratory, it is a convenient and sure electromotor, the use of which overcomes many experimental difficulties.

Applied to lighting, the pile, joined to thirty-six Faure accumulators, can operate five open-air incandescent lamps of our system for a period of five hours. We estimate that it might light eighteen to twenty Edison lamps for the same length of time. In both cases the expense would be, with an equal light, much higher than that of gas, but a little lower than that of stearine candles.

Applied to the production of motive power the same pile would consume 2·7 francs per 360,000 effective kilogrammeters. The expense, which is much higher than that of machines, is yet less than with the piles hitherto employed. We are laboring to reduce the cost prices still more. But we believe that in the same conditions under which it is offered at present, our pile can even now be admitted to laboratories and adopted in the dwellings of some amateurs.

ELECTRIC APPARATUS AT THE BELGIAN EXHIBITION.

WE represent in the accompanying cuts three small apparatus which were shown at the Belgian Exhibition, and which are not of sufficient importance to merit, each of them, a separate article. The first of these (Fig. 1) is a telegraphic

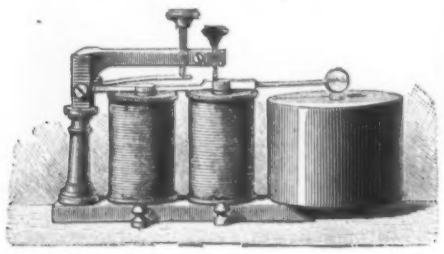


FIG. 1.—IMPROVED TELEGRAPH SOUNDER.

apparatus employed for receiving, and is a modification of the "sounder" of the Americans. In order to increase the noise of the armature, the latter is made to terminate in a small hammer which strikes against a brass drum. The two regulating screws shown in the figure are designed, one of them to limit the motions of the armature, and the other to give tension to the elastic strip which serves as an opposing spring. In Belgium there are few offices that receive through dispatches; the station that desires to transmit is put in direct connection with the one that is to receive. In the intermediate offices which give such a communication the apparatus in question interposed in the line permits of reading the correspondence. Besides, there is an increasing tendency in Belgium to follow the example set by Americans, and to substitute in the reception of dispatches the sounder for the Morse registering apparatus. The small

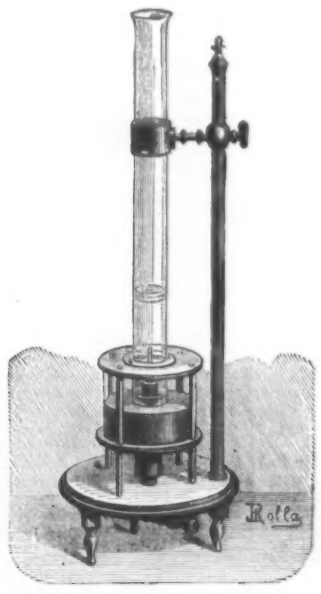


FIG. 2.—SOMZEE'S HARMONICA.

apparatus shown, then, will tend to become of general use in that country.

Fig. 2 represents an apparatus designated by the name of Somzée's Harmonica, and is designed to prevent accidents caused by fire-damp in mines. It is an apparatus in which a flame is kept burning in a glass chimney, the draught being so regulated that in pure air the flame is silent, but transforms under the influence of a certain proportion of fire-damp and then makes a singing sound. Naturally, the flame is regulated in such a way that the singing occurs before the mixture presents any danger of explosion.

The apparatus shown in Fig. 3 is an electric regulator by the same inventor, in which the sloping tubes cause finely

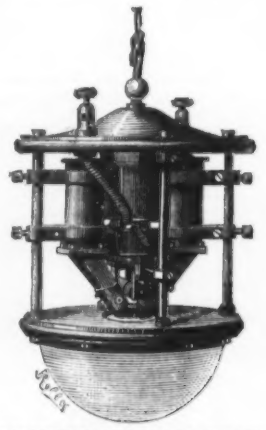


FIG. 3.—SOMZEE'S ELECTRIC REGULATOR.

powdered carbon to fall into the arc. To thus increase the quantity of solid particles raised to incandescence is no doubt an ingenious idea, but we do not believe that it is a practical one.

ELECTRICAL ACCUMULATORS, OR SECONDARY BATTERIES.

By PROF. OLIVER J. LODGE, D.Sc.

A BATTERY is an arrangement for setting electricity in motion—*i. e.*, for producing an electric current by means of chemical action. It generally, or always, consists of a liquid able to conduct electricity, and of two solid conductors immersed in it, on which it is able to act chemically. If the two conductors differ in the smallest degree in respect of their chemical affinity for some active constituent of the liquid in which they are immersed, then, as soon as they are joined by a wire, a current is always found to flow—strong or weak, according to the degree of the difference between the surfaces of the two conductors, and also according to the dimensions and nature of the connecting wire and of the conducting liquid.

The distinction between a primary and a secondary battery is in no sense an important one when we are considering either as the producer of a current; and we may have in our minds an old Volta cell, or a Smee, Grove, or Daniell, just as satisfactorily as a Planté or a Faure, while we consider the ensuing few theoretical remarks.

I shall use the term "radicle" in preference to "element," as being more general. Radicles may be elementary, but they may also be compound. The atom of hydrogen, of oxygen, or of lead, is a radicle, but so is the group SO_4 or NO_3. A radicle is any group of atoms that can combine, or be removed from combination, with another group. Chemists have long been accustomed to divide radicles into electro-positive and electro-negative, or "basylous" and "chlorous," though they have been slow to recognize the full physical meaning of this distinction. They have also classified them into monad, diad, triad radicles, and the like; and without entering into the disputed question of whether atomicities are fixed or variable, it is absolutely certain that in a definite compound, and when released from definite compounds, certain radicles are monad, diad, or triad, as the case may be.

It is, moreover, known that radicles can exist temporarily in the free state, when they are said to be dissociated; and that many liquids—not to speak of gases—contain a number of such dissociated molecules, the number depending on the temperature as well as on the nature of the liquid, and being on the average pretty constant—that is, they are equally distributed through the whole liquid, and if some are by any means removed, more will at once be formed to keep up the average. Not that any one radicle need remain long dissociated—there is, no doubt, a continual interchange—but the average number dissociated is definite under definite physical conditions.

Now there is a large class of liquids whose dissociated radicles are all charged with electricity—half of them with positive, and these are they which chemists call electro-positive or basylous radicles—half of them with negative, called therefore electro-negative or chlorous. Moreover it was shown by Faraday that the charge possessed by every monad radicle, of what kind soever, is precisely the same in quantity, though it may differ in sign; and that diads have twice, triads thrice this atomic charge and so on. The existence of these charges is certain from the facts of electro-chemistry, and the electrical charge appears to be the essential condition for even the momentary existence of a free radicle. It further appears that when two opposite radicles combine their charges are either lost or are masked by proximity; and that before two radicles of the same kind can unite into a molecule their charges must be given up to some third body. A liquid which possesses such dissociated and oppositely charged radicles, sauntering about in it, is *ipso facto* susceptible of being decomposed by electrical means, and is called an electrolyte. Liquids which have no such charged and dissociated molecules are not electrolytes, and will not conduct electricity. Electrolytes conduct electricity by a bodily transfer in opposite directions of the oppositely charged radicles; they conduct it, in fact, as a convection current, or rather perhaps of two equal opposite convection currents, one of the positive radicles, the other of the negative. The resistance of the liquid depends upon the slow shearing asunder of these two sets of radicles by a process closely analogous to diffusion, for it is possibly only assisted or directed by electricity in the immediate—molecular—vicinity of the electrodes.

What are these electrodes? They are conductors introduced into the liquid, with the property of exerting upon the charged radicles in their immediate neighborhood unequal, or else opposite, forces. Thus, suppose they are two plates of platinum connected with a battery, so that one plate is always +, the other always —; and suppose for simplicity that the dissociated radicles are hydrogen—electro-positive, and oxygen—electro-negative, respectively. Oxygen atoms close to the positive electrode are attracted by it; they deliver up their charges to it, and uniting into molecules, rise as gas. Their places are taken by others from the slightly more remote region, and so on, a virtual procession of oxygen atoms continually taking place toward the positive plate, each carrying its charge with it. The same thing happens on the hydrogen side, only that twice as many hydrogen atoms take part in the action, the charge of each being half that of an oxygen atom.

This, then, appears to be the state of things in ordinary electro-chemical decomposition; only the radicles liberated on the surface of the electrode will combine with it, if in any way possible, instead of merely combining with each other, and becoming free. Thus the hydrogen alloys itself as well as it can with the platinum; and the oxygen, if it finds any copper or other less noble metal on the surface of the electrode, will readily combine with it; the ordinary chemical affinities being enhanced by the electrical attractions.

But now, instead of two oppositely charged plates of the same material, let us immerse in the liquid a plate of zinc and a plate of copper, or any two metals which have a different affinity for oxygen. The oxygen atoms are now attracted to the zinc just as they were to the positive plate, but apparently by a chemical, not an electrical, force. It may be possible ultimately to reduce chemical forces to electrical ones, or *vice versa;* but at present it seems necessary to draw a distinction between them. This attraction for the oxygen is, as before, only to be supposed to be effective within far less than a microscopic distance of the plate. The replenishment of the oxygen into this region is wholly carried on by diffusion and fresh dissociation. The copper on the other side pulls the oxygen too, but less powerfully. Nothing more than slight motion and very slow combination, however, is found to go on so long as the two plates are kept separate, provided both are pure and homogeneous; but the tending of the negatively charged oxygen toward the zinc makes it transfer negative electricity to the copper as soon as they are connected by a wire.

The copper so connected, being now negatively charged, actually repels the oxygen atoms, and is protected from their attack, while it attracts the hydrogen. We now therefore have the continuous opposite processions again, the oxygen atoms combining with the zinc, and neutralizing by their charges positive electricity at its surface; in other words, partially giving up negative electricity to it; the hydrogen atoms going to the copper, hydrogenizing it to some extent, but soon giving up their positive charges to it, uniting with each other and escaping from the liquid. A constant current must therefore be flowing along the connecting wire, of negative electricity from the zinc to the copper, of positive from the copper to the zinc.

Next, suppose two plates of the same metal, say both platinum or both lead, not connected with any battery, but with their surfaces in different chemical conditions—say one coated with hydrogen, the other with oxygen. Plainly the same kind of action can go on. The oxygenized plate will be attracting the hydrogen like the copper, or like the negatively charged plate connected with the pole of a battery; the hydrogenized plate will behave like the zinc or the positively charged plate. The positive current will flow along the connecting wire from the oxidized plate to the hydrogen-coated one.

We have thus a battery which will maintain a current so long as the plates continue coated or combined with the two gases; but the action of the current is obviously to destroy these gases, and restore the plates to a condition of equality. A battery may be made then, either of two different metals, one of which attracts oxygen more than the other—this case we will not now further consider—or else of two pieces of the same metal, one more oxidized than the other, or one more hydrogenized than the other; or, still better, one oxidized and the other hydrogenized. Take, for instance, two plates of lead and immerse them in dilute sulphuric acid; let one be bright and metallic, the other rusted over with a coat of oxide of lead. As soon as metallic communication is made between the two plates, a positive current of electricity continually flows along it from the oxidized plate to the other, the bright plate becoming gradually oxidized, and the other becoming gradually reduced. If the plate has been oxidized, by exposure to hot air, or by ordinary chemical means, such a battery would be called a primary one; if the coat of oxide has been produced by passing through the cell an electric current from some independent source, then the battery is called a secondary one.

A Planté and a Faure cell, though the process, and more especially the time, of formation is different, are, when formed, pretty much the same thing; and consist of two plates of lead, one coated with black peroxide of lead (PbO_2), the other with a spongy material consisting of metallic lead in a fine state of division and more or less alloyed with hydrogen; both plates immersed in dilute sulphuric acid of about ordinary battery strength. Two plates in this condition must, as already explained, give a current when connected by a wire, the positive current flowing along the wire from the peroxide coated plate—the + plate—to the spongy metallic — plate, and back through the liquid in the other direction; the spongy lead becoming gradually oxidized, and the peroxide reduced to some lower oxide, all the time the current lasts, that is, until the condition of the surfaces has become either temporarily or permanently the same. In order to bring the plates into the active condition, they are first coated with oxide of lead, either electrically—by Planté, or mechanically—by Faure, which is then acted on by an electric current passed through the cell for some considerable time, the current being made to enter the liquid at the plate which is to be peroxidized, and to leave it at the plate which is to be reduced. Hence the former of these plates may be permanently labeled +; for, when charging the cell, the current enters at it, and when discharging the cell, the current sets out from it. The other plate is similarly always —. There need, therefore, be no ambiguity about these terms. The + plate is always to be connected with the positive pole of the dynamo, whether the latter is supplying the current to the battery and charging it, or whether the dynamo is receiving the current from the battery and being driven by it.

THEORY OF ELECTRO-CHEMICAL DECOMPOSITION.

It has been already stated that electricity was conducted through a liquid by means of two opposite processions of the constituent—dissociated—radicles of whatever substance in the liquid is undergoing decomposition, and that every such radicle possesses a certain definite charge of electricity, which it carries with it and delivers up to the electrode, either when it is set free by combination with its fellows, or else when it is made to combine with something in metallic communication with the electrode. It was also stated that the charge of electricity possessed by a dissociated monad radi-

* The maximum external work, calculated by means of the expression, $T = \frac{E^2}{4gR}$, is, then, equal to about 0·2 of a kilogrammeter per second.

† We speak of *formation* only. In order to *charge* accumulators economically, we must necessarily have recourse to machines.

cle is constant; and that diads have twice this charge, triads thrice, and so on. From these considerations it follows—as was proved by Faraday—that for a given weight of substance decomposed, a definite quantity of electricity is required; a quantity which will be known as soon as we know the number of atoms liberated, the electrical charge of each, and the weight of each. Let q be the dissociation charge of a free hydrogen or other monad atom or radicle. We do not know the value of q yet, we only know that it is perfectly definite and unchangeable. Let m be the weight of any atom or compound radicle released from a combination in which it acted as a k-ad; in other words, let its active atomicity have been reduced by k, or let k be the number of bonds which have been broken in the act of making it a free radicle—whichever way of expressing it is preferred—then it is necessarily possessed of an electrical charge kq.

Let N be the number of such atoms delivered up to an electrode in any time, then in the same time a quantity of electricity $Q = N\,k\,q$ must have passed through the cell; and the weight of the substance liberated in the same time is Nm—call this M. Then

$$\frac{M}{Q} = \frac{m}{kq}$$

Now, in the right hand side of this equation k is the only thing we know; we only know the relative weight of different atoms, not the absolute weight of any. Let h be the absolute weight of a hydrogen atom, and w the number ordinarily known in chemistry as "atomic weight," viz , the number which expresses the weight of any atom relatively to hydrogen, so that $m = w\,h$; then the above equation may be written

$$\frac{M}{Q} = \frac{w}{k} \cdot \frac{h}{q}$$

Now, though neither h nor q is yet known, their ratio has been determined by careful measurement, and it is $\frac{1}{9{,}505}$ in C. G. S. units; in other words, the electrical charge of a free hydrogen atom is 9,505 times its weight in grammes. And the charge of any other radicle of atomic weight w and with k free bonds is $\frac{9{,}505\,k}{w}$ times its weight in grammes.

If the weight of the substance be expressed in pounds, and the quantity of electricity concerned in its liberation or decomposition in Ampère-hours—as for practical purposes is rather convenient—the above number 9,505 becomes 12,020, or with sufficient accuracy in ordinary cases, 12,000. So we will now repeat the above equation in an easy and practically useful form:

$$\frac{\text{Weight of substance acted on in a single cell, in pounds}}{\text{Quantity of electricity passed through it, in Ampère-hours}} = \frac{\text{ordinary "atomic weight" of the substance}}{\text{12,000 times the number of bonds released per atom of the substance.}}$$

Whether the "substance" is the constituent which is liberated at the positive or at the negative pole, or whether it is the original compound, which is not "liberated" at all but decomposed, matters nothing. The above statement is perfectly general and universally applicable. It applies also when it is recomposition that is going on instead of decomposition.

The expression "number of bonds released or joined per molecule" is not a happy one, but the phrase "change of valency" is no better, and the very simple meaning intended to be expressed is best conveyed by an example. Suppose $CuSO_4$ is being decomposed; two bonds are released when Cu separates from SO_4, hence

$$\frac{\text{Weight of sulphate of copper decomposed}}{\text{Quantity of electricity passing through it}} = \frac{63{\cdot}5+32+64}{24{,}000}$$

But we might equally well write—

$$\frac{\text{Weight of copper deposited}}{\text{Quantity of E required}} = \frac{63{\cdot}5}{24{,}000}$$

Take as another example the decomposition of common dilute sulphuric acid, with copper electrodes, say,

$$\frac{\text{Weight of hydrogen set free}}{\text{Quantity of E passed through cell}} = \frac{1}{12{,}000}$$

$$\frac{\text{Weight of sulphuric acid decomposed}}{\text{Quantity of E}} = \frac{98}{24{,}000}$$

$$\frac{\text{Weight of sulphate of copper formed at the expense of the oxygen electrode}}{\text{Quantity of E}} = \frac{159{\cdot}5}{24{,}000}$$

Suppose nitrate of silver is the substance acted on. Here only one bond is released per molecule, so

$$\frac{\text{Weight of silver deposited}}{\text{Quantity of E}} = \frac{108}{12{,}000}$$

$$\frac{\text{Weight of nitrate of silver decomposed}}{\text{Quantity of electricity}} = \frac{170}{12{,}000}$$

Finally, suppose the substance acted on is PbO, the protoxide of lead, then

$$\frac{\text{Weight of litharge oxidized to peroxide}}{\text{Quantity of E required.}} = \frac{223}{24{,}000}$$

Weight of litharge reduced to metallic lead, the same.

Thus a current of one Ampère is able to oxidize on one side of a Faure cell $\frac{223}{24{,}000}$ lb. of litharge per hour, provided there is no waste, nor any gas given off, and to reduce the same amount on the other side. Or, every pound of litharge on either side of a Faure cell requires 108 Ampère-hours for its reduction and oxidation.

If, instead of one cell, a number n are taken and arranged in series, and the current sent through them, all the above action goes on in each cell, so of course the total decomposition will be n times as great.—*The Engineer.*

EXISTENCE OF LITHIA AND BORIC ACID IN NOTABLE PROPORTIONS IN THE WATER OF THE DEAD SEA.—In 1 c. c. of Dead Sea water there is a quantity of lithia sufficient to show the spectrum of this substance at least a thousand times. The same water contains also so much boracic acid that it can be practically recognized in the product of a single c. c. of this water. Hence the author infers that the present waters of the Dead Sea are the residues of an inland sea analogous to the Caspian or the Karabogaz.—*M. Dieulefait in Comptes Rendus.*

TATHAM'S IMPROVED DYNAMOMETER.

THERE has for a long time a want been felt for a correct and convenient dynamometer that should be capable of general application. All instruments that have been devised up to the present time leave much to be desired with respect to one or the other of the requisite qualifications; the Prony brake, which is the most accurate, absorbs the motive power and does not transmit it; dynamometers of the Morin type, which rank next in order for exactness, are limited in their application to small powers; and, among other very numerous apparatus, it would be difficult to find one in which the friction of the instrument was not largely represented in the indications given by it.

The present increasing production of electricity adds another to the many uses for which a good dynamometer is required, and here, as in other cases, accuracy is the most desirable quality. A study of the problem has led Mr. W. P. Tatham to seek its solution in a device (shown in the accompanying cuts), based upon the application of a new principle.

In Fig. 1 the arrows indicate the motion of the belts, and the frame of the apparatus is left out of the question, so that the principal parts of the mechanism can be more clearly seen. A is the first driving pulley of the dynamometer, fixed on a shaft which may be actuated by any sort of power whatever; B B′ are two semicircular oscillating pieces, which are capable of moving around their central knife-edges, C C′, that work in hollows formed by the intersection of two small planes. These semicircles are connected together by the links, D D′, and likewise by the aid of knife-edges, and each of them carries two pulleys E F and E′ F′. The pulley is so adjusted and centered that the central knife-edge, C, shall coincide with the point at which the belt, a, is tangent to the pulley, E, such point being taken in the middle of the belt's thickness. Through such an arrangement, the power of the belt passes directly through the point of rest of the frame, B, and, consequently, has no tendency to cause the latter to oscillate.

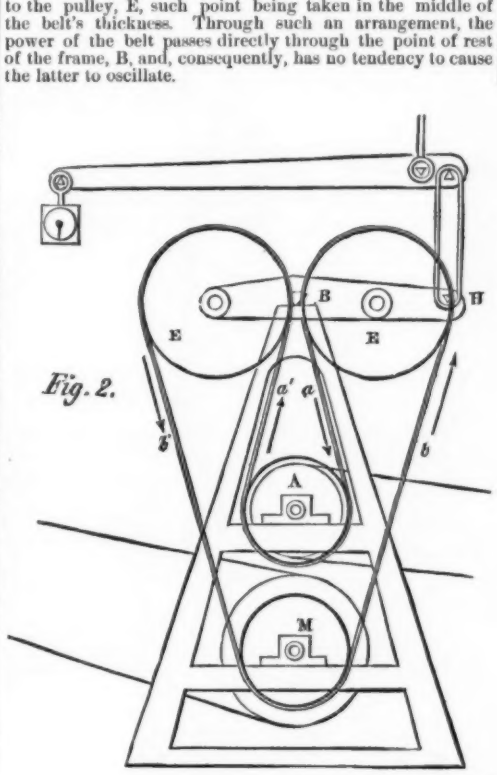


Fig. 2.

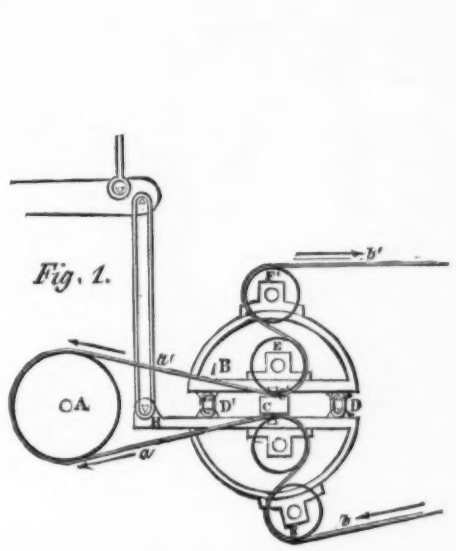


Fig. 1.

TATHAM'S DYNAMOMETER.

The pulley, F, may be adjusted upon the circumference of the piece, B, and is placed in such a position that the belt, b, coming from the machine to be tested, makes its point of tangency with the pulley, F, a right angle with the straight line that unites the tangential point with the central knife-edge, C. To the frame, B, there is attached an arm that carries the knife-edge, H, with which is connected the joint of the scale beam or measuring apparatus. The distance between the knife-edges, H, and C, is equal to that comprised between the knife-edge, C, and the point of tangency of the belt, b, with the pulley F, taken as before in the middle of the belt's thickness.

The result of such an arrangement is that the only influence that tends to cause the piece, B, to oscillate is the reaction of the belt, b, which is exactly equal to the action of the latter on the machine to be tested. In the same way, the action of the part, b', of the belt upon the piece, B′, is exactly equal to the reaction that the belt exerts on the machine. The pieces, B B′, being connected together by joints and knife-edges, the difference of the tensions upon b and b' tends to cause B and B′ to oscillate, and this difference acts alone on the scale beam—friction, save that of the knife-edges, being completely eliminated. The roughly constructed model which has been tried gave indications of surprising accuracy when tested with a brake. In order to demonstrate the suppression of friction, the pulleys, E′ and F′, were keyed without giving rise to any change in the power indicated.

According to the inventor, there is no reason why this machine, when properly constructed and adjusted, shall not indicate exactly the power absorbed by the transmission of motion of a watch as well as that given by a water-wheel; but the apparatus as yet lacks one very essential quality of a good machine, it will not work properly when a little out of order. When the axles of the pulleys become worn, the latter become displaced, as well as their points of tangency with the belts, and the accuracy of the indications is vitiated.

In order to remedy this trouble, Mr. Tatham has modified the apparatus as shown in Fig. 2, in which the arrows, as before, indicate the direction of the belts. A is the principal driving pulley and its shaft; and a and a' are the two belts that connect A with the two pulleys, E E′, fast on the oscillating frame, B. These belts do not pass through the tangential point, but only their direction does. The piece, B, is balanced on the knife-edge, C, and is provided with a knife-edge, H, to which is connected the joint of the scale beam. The distance between the knife-edges, C and H, is equal to the effective diameter of the pulleys, E and E′. $b\,b'$ are the belts that connect these two pulleys with the pulley, M, which here takes the place of the machine to be tested in the description of the apparatus shown in Fig. 1. It is important that the belts, b and b', shall not make with the vertical an angle less than the belts, a and a'. The index will show the power exerted upon the pulley, M, whose friction will be included. The friction of the pulley and the shaft, M, may be determined exactly by adopting a simple means for estimating the combined tension of the belts, b, and b', on the pulley, M; and then the indications furnished by the dynamometer operating loaded and unloaded will permit of calculating the friction when the apparatus is loaded.

The velocity of the belt may be measured by the aid of a counter, and a complete indication of the power may be obtained by combining a multiplied motion of the oscillating frame with a regular motion of a paper band unrolled from one of the axles. A thorough examination of the apparatus under consideration will show that no wear and no probable change in the thickness of the belt can materially affect the accuracy of the indications.

The oscillation of the frames may be very slight. In the model constructed, supposing that it were sufficiently strong, a power of 320 pounds would be indicated by the spring balance of the beam, and would correspond to a motion of 0·38 of an inch of the knife-edge, H.

By taking the middle of the belt's thickness as a starting point for measuring the effective diameters of the pulleys that transmit the power, the inventor has followed the indications given by the operations, and found them to be confirmed by preliminary experiments that he had made. This point ought to be examined with care in order to construct a perfect machine.

A third form of the dynamometer may be obtained, in which is combined the accuracy of the first with the resistance to wear of the second, by dividing the oscillating frame, B, of the second model into two parts, connected with one another by couplings—each of these parts having its own point of bearing upon the line passing through the thickness of the belts, a and a', all the belts being vertical and acting at a right angle upon the levers.

THE SPECIFIC HEAT OF STEAM.

REGNAULT'S DETERMINATION OF THE SPECIFIC HEAT OF STEAM.*

By J. MACFARLANE GRAY.

REGNAULT'S experiments on the specific heat of vapors have been interpreted by Regnault as giving results not at all in accordance with the deduction from the kinetic theory of gases, that for matter traveling in single molecules, the product of the molecular weight by the specific heat is a constant for all substances. I have been led, by considering the order of temperature-pressures for steam, to conclude that the above deduction is true for steam; and I have no doubt, also for all matter traveling in single molecules. When, in 1880, I laid my conclusions before the Physical Society as being corroborated by Regnault's dynamical experiments, it was objected that Regnault's direct thermal experiments gave results widely different from my conclusions; and the report on my paper was that that difference proved that in the corroborations I had pointed out, I had been led away by merely numerical coincidence.

I will now show that Regnault's thermal experiments have been misinterpreted by Regnault himself, and that he ought to have read the specific heat of steam, according to his experiments, to be exactly in accordance with the deduction of the kinetic theory.

The method of the experiments was to generate steam at 100 deg. Cent., to superheat it under atmospheric pressure to, say, 125 deg. in one set of experiments, condensing it in a calorimeter to ascertain what quantity of heat was given up. down to 0 deg. In a second set of experiments with the same apparatus, the temperature was raised to, say, 225 deg., while the steam was still at atmospheric pressure; this was also condensed in the same calorimeter. It was found that the heat given up by the steam at 225 deg. exceeded that given up by the steam at 125 deg. by 48·051 units of heat; and, dividing by the difference of temperature (100), Regnault found 0·48051 for the specific heat of steam at constant pressure.

In these experiments the superheating to 125 deg. was,

* Read before the Physical Society on February 25, 1882.

no doubt, intended to thoroughly dry the steam, so as to get, in the quantity of heat abandoned in the first set of experiments, the entire heat of complete gasification, because if still some moisture remained in the steam, the latent heat of evaporation of that moisture would be included in the difference-quantity supposed to be due to the specific heat of temperature-raising, and, by that amount, the result would be too high.

It appears to me that the completion of the evaporation of suspended moisture cannot be accomplished between 100 deg and 125 deg.; but it will be more likely to be carried on between 125 and 225 deg. Particles of liquid remain at the pressure-temperature whatever be the superheated temperature of the gas in which they are suspended. The rate of evaporation of those particles will therefore depend upon the temperature difference; and in the lower range of temperatures but little of the moisture will be evaporated in its rapid passage through a worm heated to only 25 deg. in excess of the pressure-temperature. In the second set of experiments the excess of temperature was 125 deg.

To test this, let similar experiments be made at 100 deg.; and if the resultant apparent specific heats between 100 deg. and 125 deg. are higher than those obtained by Regnault between 125 deg. and 225 deg., then my argument is demolished; but if the results are smaller, then my suspicions have been justified, and a correction is required on the results as given by Regnault. Fortunately for my object, Regnault has left us (in vol. i., at page 695) the data of thirty-eight reliable experiments on the "total heat" of steam at 100 deg. down to 0 deg., giving the mean = 636·70 units of heat. I have, with this "total heat" for 100 deg., compared the results of the experiments on the steam of 125 deg.—in precisely the same way as Regnault worked for the interval between 125 deg. and 225 deg. (these experiments are recorded in vol. ii., pages 167 to 178). The results of my calculations are given below. The first two series were merely preparatory trials to arrive at the best form of apparatus; and only a few grammes of vapor were passed through the worm at each of those experiments. In the third and the fourth series ten times as much vapor was passed through on each occasion. Regnault says: "J'ai pu opérer ainsi sur des quantités de vapeur beaucoup plus considérables, et diminuer l'importance relative des corrections produites par les causes perturbatrices." This consideration is still more important when the range of temperature is limited to 25 deg., only one-fourth of the range from which Regnault deduced his result. The large calorimeter was used only in the third and fourth series.

First Series.	Second Series.	Third Series.	Fourth Series.
0·280	0·546	0·299	0·386
0·465	0·591	0·314	0·381
0·417	0·567	0·349	0·346
0·377		0·375	0·309
0·463	Mean 0·567	0·400	0·427
		0·411	0·463
Mean 0·400		0·349	
		0·413	Mean 0·3853
Preparatory trials.		0·405	
		0·415	
		Mean 0·3721	

That the method of calculation may be perfectly clear, I give the particulars for the first experiment in the fourth series. Superheating to 124·81 deg., each unit of vapor gave up 646·28 units of heat down to 0 deg. Steam at 100 deg. gave up 636·70 deg. down to 0 deg.

$$\frac{646{\cdot}28-636{\cdot}70}{124{\cdot}81-100} = 0{\cdot}386.$$

The quantity of vapor in this experiment was 102·62 grammes; the quantity in the first of the first series was only 8·957 grammes.

The fourth series was made with an apparatus which was an improvement on that used in the third series; and taking that series only, adding the probable amount of moisture which would remain at 100 deg. temperature (say 1 per cent. on the 0·385), the result is 0·389; this, on other grounds, I believe to be nearly correct. If, however, neglecting the other grounds for my opinion, we take the mean of the means of the third and the fourth series, we get

$$\frac{0{\cdot}3721+0{\cdot}3853}{2} = 0{\cdot}3787.$$

This is what Regnault might fairly have done.

If we now calculate what Regnault's experiments would give as the kinetic-theory result, we get the specific heat of hydrogen, at page 121, "mean = 3·4090;" and taking the molecular weight of steam = 17·96, we find the specific heat of steam

$$3{\cdot}409 \times \frac{2}{17{\cdot}96} = 0\ 3796.$$

That is to say, the kinetic theory and the thermal determination give almost identically the same number.

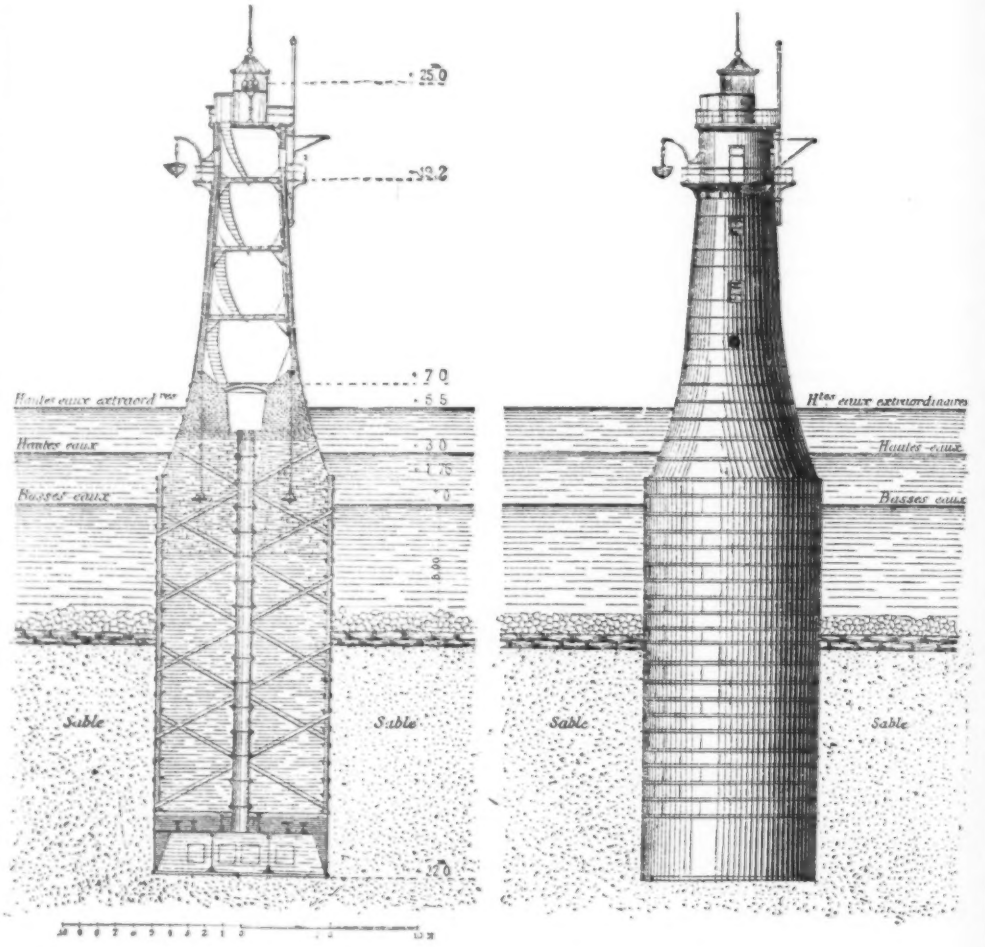
This is, I believe, the first experimental proof that the law of "inversely as the molecular weights" applies to compound gases.

THE ROTHE SAND LIGHTHOUSE AT THE MOUTH OF THE WESER.

THE mouth of the Weser, like the whole coast of the North Sea, from Jutland to the Helder, is obstructed with sand-bars. A certain number of these are more or less movable, but their shifting, as a general thing, is very slow. The Red Sand bar (*Rothe Sand*) is of this character, its western border having moved several times within the last thirty years. Navigators have for a long time been petitioning for an increase of the number of lights to guide them in these quarters, and it had been decided to locate, in a place that had been selected, a third lightship. But the proposition was made, and soon adopted, to substitute for this a lighthouse to be built on the bar itself. The conditions necessary for the stability and duration of such a work appeared to be easy of fulfillment. At this spot the bottom consists of coarse sand intermingled with broken shells and fine gravel. The depth at low water is 8 meters, but in some places not far off it reaches 17, and the possibility had to be taken into consideration that a shifting of the bottom might some day give the place selected for the structure the latter depth. The currents are quite strong, especially at ebb-tide, and attain a velocity of as much as 1·2 meters per second. Finally, there is frequently found here more or less drifting ice, the numerous blocks of which are of large dimensions, and at times resemble ice fields, not of very great thickness, but of considerable extent. These local conditions dictated a solution of the problem of construction. Iron piles had been proposed, but these would not, for several reasons, answer. The great depth of the water, in the first place, rendered it difficult to employ them; and, in the second place, even had a spot of less depth been selected, the floating ice constituted a permanent danger, so to speak, and one whose effects had already been experienced in 1877, when a similar lighthouse had been destroyed by floating ice in Chesapeake Bay, U. S. It was judged preferable, then, to build up on the spot as massive an islet as possible, such a project being rendered apparently feasible in view of the progress that had been made in recent years in the art of constructing subaqueous foundations. This kind of foundation possessed one valuable advantage, and that was the possibility of dispensing with scaffolding, the use of which, in view of the depth of the water, and its frequent agitation, would have been daily attended with great risks and dangers. The reasons briefly indicated in the preceding remarks led, then, to the adoption of a project devised by Mr. Hancke, of Bremerhaven, and of this we shall give a short description, taken from the specifications.

The foundation consists of a caisson 23·76 meters in height, made of 8 millimeter boiler-plate, reaching to a depth of 22 meters below the lowest tides. At the base of this is the working chamber, 2·5 meters in height.

From the top of the caisson, filled with masonry, rises the base, which has a height of 5·24 meters, a diameter of 9·9 meters at the bottom, and of 6·4 meters at the top. From this foundation rises the tower, in the form of a truncated cone, to a height of 12·2 meters, with a bottom diameter of 6·4 meters, and with a top diameter of 4·4 meters. At the upper extremity of the tower is situated a cylindrical watch-room and an external balcony, and directly above the watch-room is the lamp, which contains a catadioptric apparatus of the fourth order, whose focal plane is 25 meters above the level of low tides.



THE ROTHE SAND LIGHTHOUSE.

The lower part of the caisson, as we have before said, forms a working chamber. This is strengthened by consoles placed against the external walls, and is divided off into compartments by six vertical partitions. The object of the latter is simply to stiffen the chamber and not to divide the work up between several rooms. The space between the consoles of the circumference is filled in with a masonry of over-baked bricks laid in cement and forming a straight vaulting. The ceiling of the chamber is strengthened with old rails so as to be able to support the load of masonry above it. The base of the latter consists of a layer of beton, which was laid before the caisson was put in place. The superstructure consists of an envelope of 8 millimeter boiler-plate up to the level of the upper gallery. This envelope is filled in with solid masonry to a height of about 3·2 meters, at which point there is formed in the center a reservoir for water. At a height of 7 meters, and directly over the reservoir, is the first story of the tower properly so called; and starting from this level the internal lining of the work is to consist solely of brick masonry in order to render the structure more habitable. The total height is divided into four stories, which are reached by very firmly arranged stairways. The fourth story forms a chamber for the watchmen, and looks out on the principal balcony, where are arranged life-saving apparatus, and a boat suspended from davits.

The work had to be done in the following manner: The caisson was constructed entirely on land, at Bremerhaven. It there received the lower lining masonry, and the beton which fills the space over the ceiling of the working chamber. One of the angles of the caisson was provided with a rudder so as to give the total floating part when launched a form approaching that of a ship. The total height of the constructed part was 17·6 meters, which was provided internally with cross-braces, and a platform carrying the boiler, the air-compressors, and the air-locks. Windlasses for the anchors and a bilge-pump were likewise placed on board.

Thus equipped the caisson was launched and set in motion toward its final destination, 47 kilometers distant. The first experiments on navigation in port gave very satisfactory results, but when the high seas were reached and currents had to be encountered the difficulties notably increased. The water rose into the working chamber and occasioned unexpected resistances. Two of the strongest tugs had great difficulty in keeping the caisson in the current, and during the night the cables of one of them snapped, and the caisson ran on to a sand bar. It was easily floated off again, however, at the next high-tide, and reached its destination finally without having suffered any damage whatever. The time consumed by the trip was three days. The caisson was fixed in its final place by means of four anchors prepared for the purpose, and by letting water flow into the upper empty space. During the latter operation the caisson had assumed an exactly vertical position, but, on sinking, it unfortunately careened and took a position inclined toward the S. E. at about 21° from the vertical. It slowly righted itself, however, by virtue of its own weight until it finally assumed a vertical position. This position had so nearly been reached on the 30th of May that the engines could be set in operation. The bottom being of sand, scarcely anything but the sand pump was employed for excavation and the emptying of the chamber, the descent being effected very rapidly.

The filling in with beton was done with more difficulty. The sand extracted could not be used, as the concordance of the work did not permit of it. The beton had to consist of sand, with an addition of one-fourth its bulk of Portland cement, and, in case of insufficiency, to be completed by broken stones, *trass*, and mortar of cement. It was found necessary to prepare the beton on board of boats held at anchor in the vicinity, or to bring it ready prepared from Bremerhaven. It was laid by means of chutes running to the bottom of the water that filled the caisson, or by means of bags thrown in and left there.

During construction care was bestowed on the consolidation of the ground surrounding the structure, this being done by making an artificial bottom over a space of 15 meters around the caisson by means of hurdles filled in with stone. While this was being done, however, an unfortunate visitation of the elements destroyed a portion of the work, and put an end to operations for the present. It is expected, however, that the work will be resumed again before long, and that the lighthouse will be built as originally projected and as above described. The total cost of the structure as projected was to be 606,000 francs.

THE HEALTHIEST AND UNHEALTHIEST CITIES.—The six healthiest cities in the United States, as measured by recent authentic reports, are, in the order named: Utica, Dayton, New Haven, Portland, San Francisco, and Lawrence. The six unhealthiest are Charleston, Memphis, Cleveland, Chicago, Jersey City, N. J., and Lynn. The six unhealthiest in the world are St. Petersburg, Charleston, Malaga, Alexandria, Warsaw, and Buda Pesth.

THE LAUER SYSTEM OF SUBMARINE BLASTING.

FOR some years past, Major Johann von Lauer, of the 2d Austrian Engineer Regiment, has been carrying out a plan of submarine blasting, which has been productive of satisfactory results, under conditions where the ordinary methods could hardly have been employed. In 1873, Major von Lauer had to remove a broken bridge pier from the bed of the Danube, under one of the bridges of the North-Western Railway, and he found it necessary to originate some system which might enable him to do this without damage to the bridge, one of the piers of which was only about 21 ft. distant from the obstruction to be removed. This obstruction consisted of masonry and ironwork, and lay in about 9 feet of water. It was not practicable to employ the ordinary system of bore holes, or to inclose the charges in the interior of the iron cylinder; and eventually he decided upon the adoption of charges of dynamite, laid upon the surface. This conclusion was drawn from the fact that dynamite exploded in the open air will fracture the substance upon which it rests; and it was inferred that it would probably do so with far greater force under a considerable body of water. The resistance of the water not being equal to that of the rock or other solid substance to be removed, some proportion of the explosive force is of course lost; but nevertheless enough takes effect upon the rock to shatter it considerably. The size of the cavity produced varies with the density of the rock and the size of the charge employed; the latter may be increased in proportion to the depth of the water. Experience has shown that the best results on hard rock are produced by a charge of from ½ lb. to 1 lb. of dynamite, where the water is at least from 5 ft. to 7 ft. 6 in. deep. The former charge of No. 1 dynamite will produce a cavity of from 4 in. to 6 in. deep, and 2 ft. 6 in. in diameter; the latter one of from 7½ in. to 10 in. deep and 3 ft. 6 in. in diameter (Fig. 1). A second charge, fired in the hollow so produced, has a proportionately greater effect, as it acts on a larger surface, and one which has already to some extent been disintegrated by the former explosion (Fig. 2). The effect does not increase proportionately after the second discharge. The number of charges is regulated by the depth of the rock to be removed, as shown in Fig. 3. In porous rock far greater results are obtained, as the force of the explosion drives the water into the pores of the stone, where it acts as a wedge. This system can only be satisfactorily employed when the placing of the charges is carefully regulated. The method adopted to insure the accurate placing of each charge is shown in Figs. 4 to 8, which give details of the blasting vessel employed. It is moored by five anchors, as shown in Fig. 5, and from its stern projects a platform, A A (Figs. 4, 5, and 7). On the outer end of this platform is fixed a movable framework, R, for guiding the bar carrying the charge; it is composed of two round wooden beams, carrying iron rails, and fastened together by iron hooks, *h*. Through the openings the placing bar, F (formed of wrought iron gas pipe), is directed to any required point. On the bottom of this bar is an iron socket, into which is inserted a round piece of wood, *c*, attached to the charge. For the easier manipulation of this bar, a wire rope or chain, *z*, is fastened to it and connected to a windlass. The roller clip, B, through which the upper part of the bar passes, enables the exact position of the charge to be fixed; while, as the platform, R R, can be moved to the positions R_1 and R_2, three rows of charges can be placed and fired without moving the vessel. By means of the bow and side anchors the vessel can be moved up or down stream. Five men are required to carry on the work; one directs the proceedings, two hoist and lower the bar, one works the chain, *z*, and the fourth supplies the cartridges.

In commencing operations upon a rock in the bed of a river, the vessel must be securely moored at the lowest point of the stream where blasting is to begin, in order to facilitate the carrying down of the fragments. The first charge should be placed at the outermost position which can be taken by the bar (Fig. 5). It is then fired by electricity and the bar drawn up. The shattered plug, *c*, is withdrawn and a fresh charge attached, which is sunk in the same position, if the required depth has not been attained by the first discharge. The bar is then moved to the next position, until all the first row of charges have been placed and fired. The frame R, is then moved to the position R_1, and the same process repeated, as is again done at R_2.

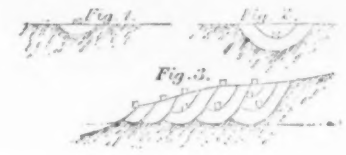
By this process a surface of from 15 to 30 square yards (according to the depth of the water) can be operated upon without moving the vessel. By means of a scale marked upon the placing bar, the depth of working can be regulated. The apparatus as described is extremely simple, and its manipulation can be easily learnt. With the gang of four men at work one charge can be fired every four minutes. The cost of labor and blasting material varies, of course, according to the conditions of each particular case. Major von Lauer gives the following details of the work which he has carried out, as a guide for others who may desire to adopt his system.

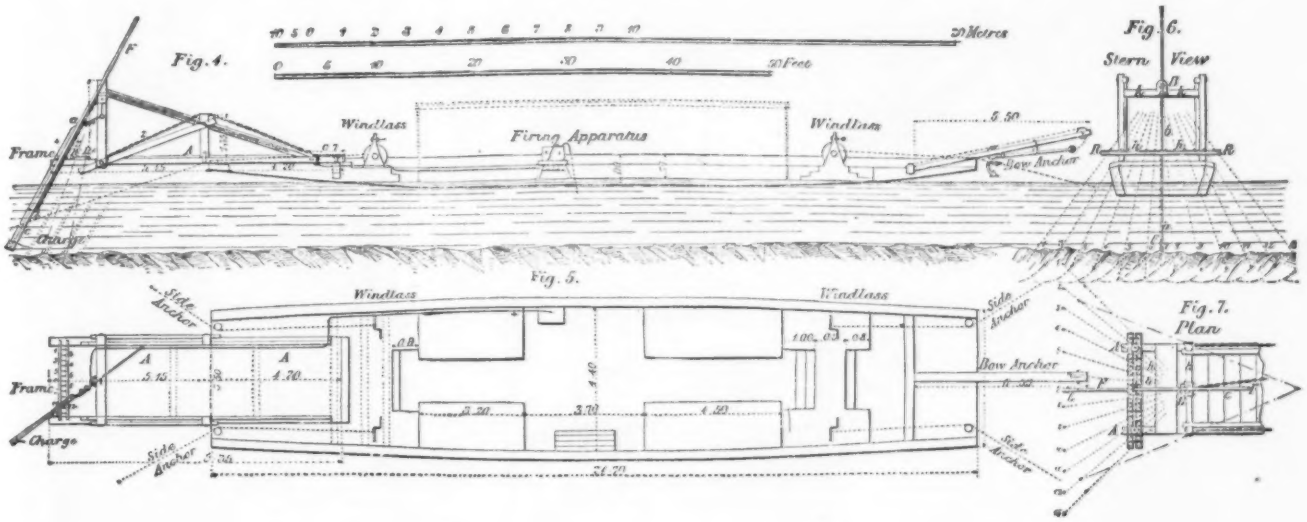
The broken Danube bridge pier already mentioned, had before been ineffectually worked upon for weeks; but by this process it was removed in fourteen days. About 58 cubic yards were destroyed, each of which required on an average 3¾ lb. of dynamite for its removal, occupied ten workmen for one-eighth of a working day, and cost in material consumed 7s. 6d., not including, of course, any charge on behalf of the vessel and permanent plant. This operation, which was the first carried on by this process, was conducted in about 8 ft. 6 in. of water. In July, 1875, Major von Lauer was engaged in deepening the channel of the Danube at the Iron Gates. Here the depth was about 6 ft., with an abnormally rapid current running; 7¼ cubic yards of rock were removed in three hours, requiring 2½ lb. of dynamite per cubic yard, and costing about 5s. in material. This latter work gave such satisfactory results, both as regards rapidity and economy, that Major von Lauer reported to the Austrian Ministry of War that his method of blasting was simpler, quicker, and cheaper in working than any of those hitherto adopted.

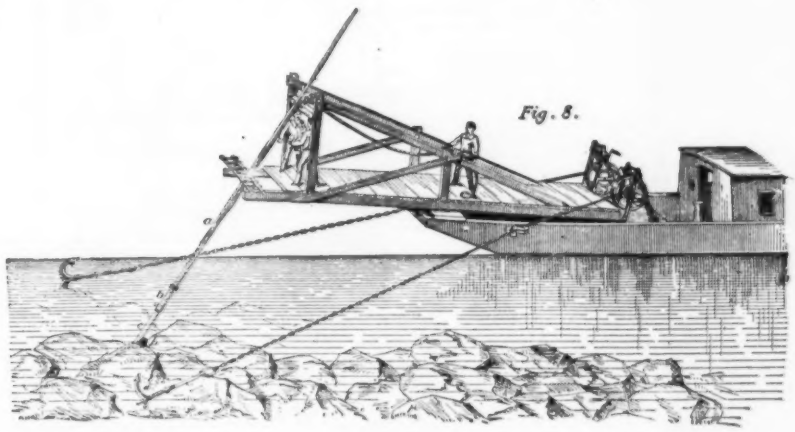
In 1878 further operations were commenced on a rock in the Danube at Krems. Although they could not be completed, they furnished valuable data of the cost per cubic yard of removing rock under water, under ordinary circumstances. It may be calculated that in 20 ft. of water 1 cubic yard of rock may be broken up by ten workmen in one-tenth of a working day, at a cost of 18s. 6d., including all incidental expenses. The material employed was new dynamite No. 1, in cartridges of two sizes, 1 lb. and ½ lb., cylindrical in form, the cases being of cardboard, treated inside and out with paraffin, to render them waterproof. They were fired by frictional electricity, generated by a field apparatus belonging to the regiment. Five men were engaged in the actual blasting operations, three were required for preparing the cartridges, which were carried by two others, thus making up the above total of ten workmen.—*Engineering.*

MONOLITHIC CHURCHES IN ABYSSINIA.

AT the last sitting of the Paris Academy of Inscriptions and Belles Lettres, M. Raffrey, who has recently returned from his travels in Abyssinia, gave an interesting description of a number of churches he had seen there which are hewn out of the solid rock. These unique structures he found in the town of Lalibeba, the capital of the province of Lasta. The place lies in a remote and out-of-the-way region, and is situated on the side of a rocky mountain. It is regarded as a holy city by the Abyssinian Christians, and is visited by numerous strangers who come to pray near the sacred relics there preserved. There are ten churches in the city, but they are not conspicuous to the eye of the traveler, inasmuch as they form integral portions of the mountain.



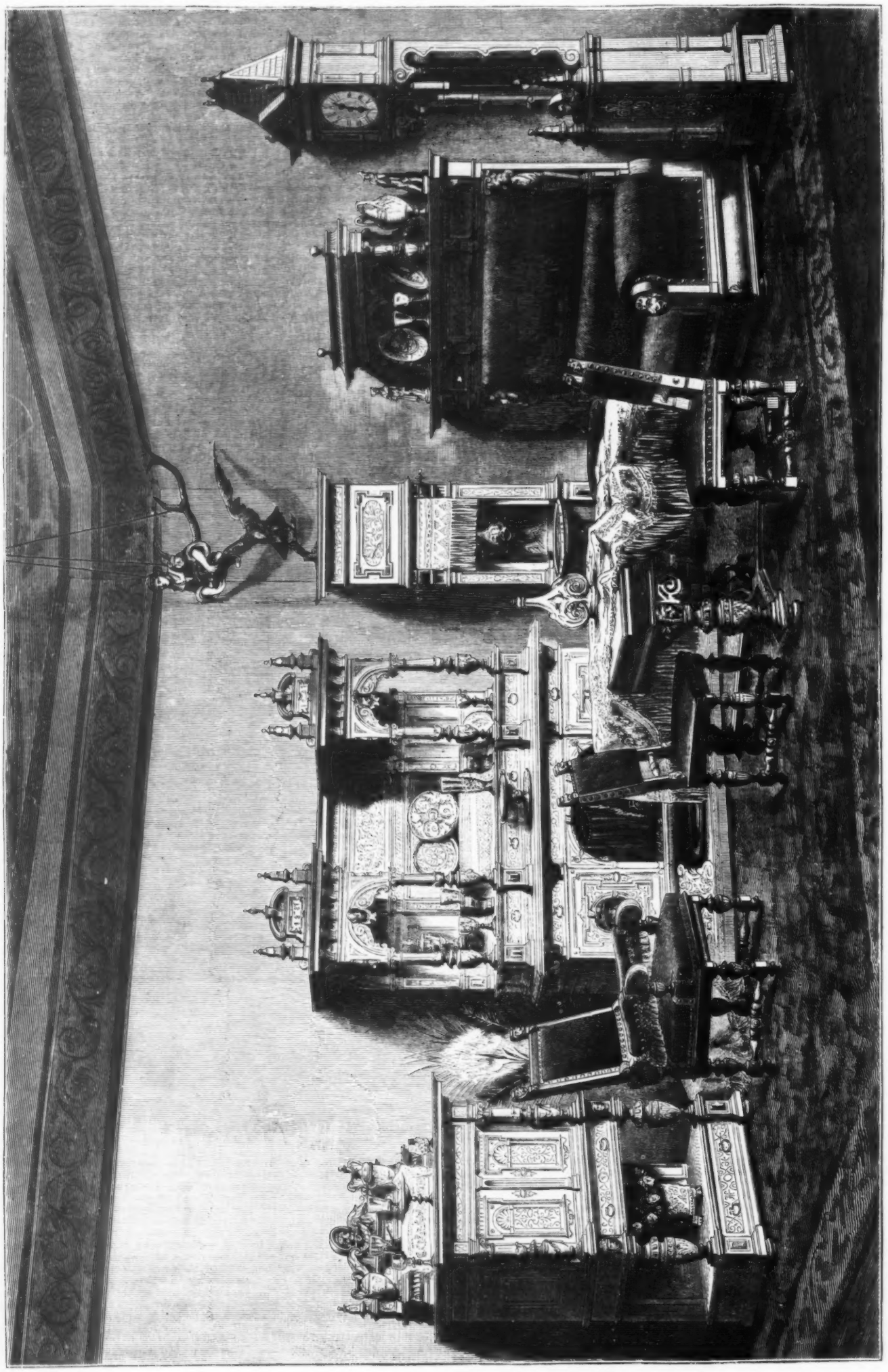




THE LAUER SYSTEM OF SUBMARINE BLASTING.

DINING-ROOM FURNITURE.

THE furniture in oak is enriched with marquetry in pear; settee and armchair are covered in red cloth, the chairs in leather. See next page.



SUGGESTIONS IN DECORATIVE ART.—DINING ROOM FURNITURE, DESIGNED AND EXECUTED IN F. W. BUERK'S MANUFACTORY IN MANNHEIM.—FROM THE WORKSHOP.

"L'ALLEGRA".
TWO PANELS IN SCREEN FOR
BY H.W.LONSDALE

"AS YOU LIKE IT" ACT 2 SC 4
ROSALIND, CELIA AND TOUCHSTONE.

DRAWING·ROOM·WINDOW·BEECH·COTTAGE·ALLERTON·
BY H.WALTER LONSDALE. MESSRS ALDRIDGE & DEACON ARCHITECTS

"LA PENSEROSA."
S. BENNETT ESQRE LEICESTER
GODDARD & PAGET ARCHITECTS

TEMPEST" ACT 1. Sc 2. PROSPERO & MIRANDA
LIBRARY WINDOW, ALLERTON.
BY H.W. LONSDALE. FOR J.R.ROCERSON ESQ
PROSPERO:
KNOWING I LOV'D MY BOOKS HE FURNISH'D ME,
FROM MINE OWN LIBRARY WITH VOLUMES THAT
I PRIZE ABOVE MY DUKEDOM.

BUERK'S MANUFACTORY IN MANNHEIM.—FROM THE WORKSHOP.

A REVIEW OF THE PROGRESS MADE IN PURE CHEMISTRY DURING THE FIRST THREE MONTHS OF 1882.

WE hope, in the following short review, to show our readers some of the principal and most interesting phenomena that have marked the advance of pure chemistry during the early part of the present year. We begin with the general, theoretical, and physical chemistry.

N. Schroder[1] has investigated the relation between the molecular refraction of liquid compounds and their chemical constitution; the former is found to increase with their atomic weight. In the study of the physical properties which were investigated, Kekule's hexagon form was found unsatisfactory, while Ladenberg's prismatic symbol proved very suitable. J. Thompson,[2] Copenhagen, polemized the statement made by Brühl[3] concerning the relations which exist between the refractive power and the combustion heat of organic bodies. More recently he has made comparisons between the different combustion heats of benzol, dipropargyl, and acetylene. He finds that the dipropargyl has three univalent and two trivalent (3 mol.), acetylene three trivalent bonds. The only explanation of the difference between the combustion heats of these three isomeric bodies that can be given is, that the carbon atoms in benzol are united by nine univalent bonds, and not, as is demanded by the present hypothesis, a union of three univalent and three bivalent bonds. J. W. Brühl and V. Zenger[4] have shown that the specific refractive power—*i. e.*, the refraction divided by the molecular weight—must not decrease with the increase of the denominator; thus, for instance, the substitution of H_2 for O. E. Chancel[5] recommends a new form—bottle shaped—for the glass balls used in the estimation of vapor densities. According to Berthelot[6] the rapidity of the propagation of explosive phenomena in gases is independent of the variation of pressure. F. L. Phipson insists upon his discovery of actinium, and also announces his finding of an allotropic modification of actinium sulphide, which does not become dark when exposed to the light. K. Angstrom[7] finds that the increase of the volume of water is proportional to the quantity of gas absorbed.

In inorganic chemistry we have but few new facts to record. New analytical methods for inorganic compounds follow further on.

M. Traube[8] has observed that, when palladium hydride is shaken with water and oxygen, instantaneously a copious quantity of hydrogen peroxide is produced. The latter is not considered as the product of oxidation when zinc and water are shaken together, but rather as the result of a process of reduction:

$$Zn+2H_2O+O_2=Zn(OH)_2+H_2O_2$$

A. Schuler[9] also has studied the formation of hydrogen peroxide as produced by the combination of hydrogen in oxygen under variable pressure. Nitrogen iodide, according to D. Hinds,[10] explodes under water whenever it comes in contact with some solid body, after that it has been kept under ammonia for several hours. Pattison Muir[11] poured a solution of bismuth iodide into three different beaker glasses containing concentrated hydriodic acid; on adding to the first 100 c. c. of cold water, there is formed a brown precipitate; on adding the same quantity of hot water to the second a red crystallized precipitate is formed, and in the third, on adding 500 c. c. cold water, a red amorphous sediment of BiOI is formed.

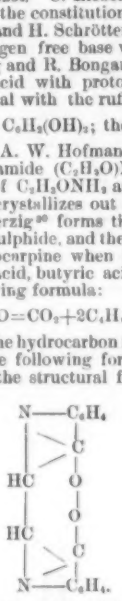
J. Violle[12] estimates the boiling point of zinc to be 929·6°. Silver melts at 954°, and so can not volatilize in the vapors of zinc. L. Setterberg[13] has prepared, in Marquart's laboratory, at Bonn, cesium and rubidium alums from the residues obtained in the preparation of lithium—from lepidolite—which contains large quantities of each, *i. e.*, rubidium and cesium. By the electrolysis of a mixture of cesium cyanide and barium cyanide, the former element was obtained. It resembles the other alkali metals, being in color silver white, ductile, soft; like potassium and rubidium, it decomposes water, setting fire to the free hydrogen and burning when exposed to the air. Maumené[14] expresses his belief in the existence of the bodies NH and NH_2, and has succeeded in isolating them. The latter is alkaline, and forms with acids well defined crystallized salts.

Of the many scientific investigations in organic chemistry, the smaller but most interesting portion is that which relates to the practical questions of everyday life. L. O. Sullivan[15] separates an α and a β starch; this he accomplished by treating flour with alcohol at 40° C.; by this means he extracts certain albuminous substances, sugar, etc.; the residue on being stirred with water at 35° to 38° gave a soluble α and an insoluble β starch, the latter forms crystallizable sugar with dilute acids, while the former does not. L. Liebermann[16] has determined the quantity of the different products developed by the destructive distillation of tartaric acid. F. Konig[17] has devised a method by which, through fermentation, it is possible to obtain 500 grms. succinic acid from 2 kilogrms. tartaric acid. Tartaric acid is mixed with a solution of ammonium citrate, and subjected to fermentation at 25° to 30° for some weeks; the liquid is then concentrated, some lime water added, and boiled until the escape of ammonia is no longer perceptible. The resulting calcium succinate is pressed and decomposed by sulphuric acid. H Kiliani[18] has discovered a desirable process for the manufacture of lactic acid by the action of either potassium or sodium hydrate on glucose. A. Studer[19] has succeeded in producing from the aniline and butyl alcohol derivatives of butyl benzol, a primary $C_6H_4<^{NH_2}_{C_4H_9}$; the butyl group shows a tendency to enter the benzol ring. The butyl phenol, $C_4H_9.C_6H_4OH$, he considers a desirable antiseptic.

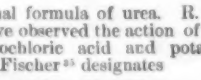
According to A. Cahours and E. Demarcy,[20] two bibasic acids, sebacic and suberic acids, may be produced by the distillation of crude fatty acids with superheated steam. Fr. Peingruber[21] has made methylnaphthalene from the products of tar oil, which boil between naphthalene and acenaphthaline; with A. Emmert he examined the fractions which boiled between 264° and 266°, and these he found to consist of different isomeric dimethylnaphthalenes. C. Seemhofer[22] found that by treating naphthalene with Nordhausen sulphuric acid and anhydrous phosphoric acid, naphthalene-tetrasulphonic acid was produced. L. Naudin[23] passed two equivalents of dry chlorine gas through one equivalent of pure oil of turpentine, and maintained them at a temperature of —50°; there was found a sirupy chlorinated compound, $C_{10}H_{14}Cl_2$, which, on being heated, decomposes into cymol and hydrochloric acid. F. Herrmann[24] has been engaged in studying the action of alkali metals on ethyl succinate, resulting in the formation of succinyl ethyl succinate. E. Bourgoin[25] dissolved 50 grms. properly neutralized potassium trichloracetate in three times its quantity of water, adding to it 100 grms. potassium cyanide; in addition to small quantities of carbon oxide and hydrocyanic acid, a large quantity of chloroform was produced. The potassium cyanide acts in the same way as the alkalies do. C. Friedel and J. M. Crafts[26] have furnished improved data bearing on the making of triphenyl-methane. To 1,000 grms. benzol and 200 grms. chloroform, they add 200 grms. aluminum chloride in small quantities; the product after being washed with water is submitted to distillation, which results in the production of 40 grms. diphenylmethane, 150 grms. triphenyl methane, and 50 grms. of a dark carbonaceous residue. P. Chastaing[26] obtained picric acid when morphine was heated with fuming nitric acid in a sealed glass tube at 100°. An increase of temperature caused an explosion. A. Haller[26] has examined an ether from the carbonic acid of borneol. H. Weidel[27] furnishes new contributions to the knowledge of tetrahydrocinchonic acid. H. Strasser and G. Schulz[27] have occupied themselves with the study of a new formation of diphenyl, and H. Hubner[27] with anhydro compounds, for instance, anhydro-orthohydroxybenzoyldiamido-benzol. C. Liebermann and J. Jacobson[27] have worked out the constitution of the β naphthochinons. E. v. Gerichten and H. Schrötter[27] have attempted the production of the oxygen free base which is the basis of morphine. E. Nötting and R. Bongart[28] obtained from the heating of sulphuric acid with protocatechuic acid a substance precisely identical with the ruñopin made by Anderson, $C_6H_2(OH)_2<^{CO}_{CO}>C_6H_2(OH)_2$; therefore it is a derivative of anthrachinon. A. W. Hofman[29] succeeded in forming acetyl monobromamide $(C_2H_3O)NHB_{r2}$, by digesting equivalent quantities of $C_2H_3ONH_2$ and Br with potassium hydrate; the product crystallizes out of ether in beautiful striated plates. J. Herzig[30] forms tiglin acid by treating guajol with sodium bisulphide, and then oxidizing. According to Chastaing,[31] pilocarpine when heated becomes transformed into carbonic acid, butyric acid, methylamine, etc., according to the following formula:

$$C_{11}H_{16}N_2O_2+5H_2O=CO_2+2C_4H_8O_2+2CH_5N+O.$$

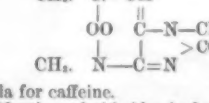
A. Baeyer[32] considers the hydrocarbon from which the indigo is derived as having the following formula, $C_6H_5{=}C{=}C{-}C{=}C{-}C_6H_5$, and for the structural formula for indigo he gives the following:



P. Griess[33] gives as the result of his examination of the action of cyanogen on picramic acid

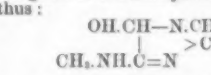


for the rational formula of urea. R. Maly and Fr. Hinteregger[34] have observed the action of bromine and water, and of hydrochloric acid and potassium chromate on caffeine. E. Fischer[35] designates

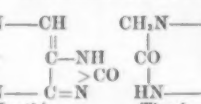


as the formula for caffeine.

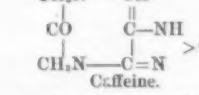
In the verification of this idea he has produced the caffoline $C_9H_{12}N_2O_2$, which is derived from caffeine by the subtraction of one molecule of methylamine and two of carbon dioxide. He regards it as a methyl urea derivative of glyoxalic acid, thus:



He has been able to synthetically produce caffuric acid and caffoline from caffein. In a later publication[36] he shows that xanthine has a close relation to guanine and sarcine, and considers the synthesis of caffeine and theobromine from guano a likelihood—probably a transitory phase for scientific purposes. The constitution he expresses by the following formula:



Xanthine. Theobromine.



Caffeine.

O. Fischer[37] has made nicotinic acid by decomposing pyridine cyanide. Iodo-bismuth compounds have been prepared by H. Krant.[37] The ethereal oil of the pepper plant has occupied the attention of A. Haller.[37] A. Bartholy and G. Papasogli[38] have communicated the interesting fact that carbon as a positive pole submerged under water is resolved into air, carbonic acid, and mellitic acid.

Passing now to the consideration of the advances made in analytical chemistry, we find that E. Johanson[39] recommends for the rapid oxidation of the carbon in the burning of filters, etc., to cool the vessel and substance until the latter has ceased to glow, and to repeat this operation. He thinks that the oxygen becomes condensed in the pores of the crucible, and hence supports the combustion when the substance is heated afresh. C. Campari washes and dries the sulphides of gold and platinum in presence of arsenic, tin, and antimony, and heats them in a test tube, distended at the lower end with ten times their quantity of a mixture of potassium cyanide and sodium carbonate till the mass melts evenly; the gold and platinum will collect in the lower part of the tube, and above them the ring shaped deposit of arsenic, etc., is found; the lower portion is removed with a file, and tested for gold and platinum. Pattison Muir[40] suggests the following method for the detection of tin in the presence of arsenic; the precipitated sulphides of the arsenic group are heated with hydrochloric acid, the undissolved residue is examined for arsenic, and three-quarters of the solution are boiled with copper turnings for ten minutes—this operation transforms the stannic chloride into the stannous chloride, and the latter reduces the mercuric chloride to the mercurous chloride, and finally to the metallic condition itself. The volumetric estimation of antimony in the presence of tin is effected by E. F. Herroun,[41] and it is dependent upon the fact that antimony chloride sets iodine free when it is in solution, which is not the case with tin. The liberated iodine may then be volumetrically estimated with sodium hyposulphide. Fr. Becker[42] recommends the use of tin foil and copper sulphate, instead of zinc dust, for the determination of chloric acid. B. Haas[43] proposes for the determination of sulphurous acid in the analysis of wine, to distill the latter in a current of carbon dioxide, and then passing the vapors through a saturated solution of iodine (made up of 5 grms. iodine and 7·5 grms. potassium iodide to the liter). L. Liebermann[44] suggests the following delicate reaction in this connection, viz.: that a few drops of iodic acid will color the distillate yellow-brown, and that by the addition of chloroform a pink-red color is produced; the test is sensitive for 1 part in 500,000. The treatise by Dr. J. Nessler[45] and M. Barth on wine analysis includes methods for the estimation of the extract; test for sugar, determinations of chlorine, free tartaric and citric acids. P. Wagner[46] attacks the position of the Imperial Board of Health, on the ground that wine must be a beverage prepared by alcoholic fermentation from grape must without any addition whatsoever. He holds that the rational gallization of inferior varieties of wine is absolutely necessary. A similar opinion has been expressed by the celebrated Prof. Dr. Fleck, of Dresden, in his work on "The Chemistry in the Service of the Public Hygiene," and whose opinion we referred to in the *Chemiker Zeitung*, v. 843. The examination of chocolate for fats, sugar, and cacao consists, according to Herbst, of the extraction of the fat by ether, and then further extraction by means of water; pure cacao contains 50 per cent. of fats. The ash of unadulterated cereals, meal, and bread contains, as Van der Berghe[47] shows, slight quantities of copper. Apothecary Pohl[48] has been engaged by the Russian Government for the purpose of finding out an easy method for the estimation of ergot in rye, flour, and bread. According to L. Janke,[49] the specific gravity of milk fluctuates between 1·0216 to 1·037; as the average of 200 examinations he gives 1·0308. The conventional test, he holds, does not give sufficiently exact data, and, therefore, he recommends the gravimetric estimation of the fat, or else the shaking of the sample with ether, and then ultimately estimating the specific gravity of the ethereal solution of fat according to Soxhlet's method. The reliability of this newly described method[50] has been confirmed;[51] also the method for the examination of skimmed milk has been improved by Soxhlet.[52] W. Rödiger[53] has examined, in different ways, lard, tallow, and tallow-like fats. J. E. de Vrij[54] has tested the methods given for the estimation of the alkaloids in the Peruvian barks, and finds the method by Prollius the best. The liquid for extraction consists of 88 parts (by weight) of ether, 8 of alcohol, and 4 of ammonium hydrate. E. Schulze[55] has communicated his belief in the usefulness of the azotometer for the examination of ammonia generated by the amines in the extraction of plants. According to P. Brouardel and E. Boutmy,[56] the alkaloids of plants have no effect on potassium ferricyanide; the ptomaines, however, instantaneously reduce it to potassium ferrocyanide. Beekurts[57] has arrived at an entirely opposite result; he finds that aconitine, brucine, conine, digitaline, nicotine, strychnine, papaverine, narceine, and codeine reduce the potassium ferricyanide. Dr. A. Stutzer[58] has been investigating the quantitative determination and the digestibility of the albuminous substances. G. Wormley[59] has been making a series of urea determinations with R. Apjohn's apparatus. The sodium hypobromite must be freshly prepared, and the solution of urea considerably diluted. In order to test the sugar in the urine, it is necessary, according to W. Muller,[60] to first remove the uric acid, for the latter has a reducing effect upon copper sulphate in alkaline solutions. Pellet and De Grobert,[61] in the application of a colorimetric determination of salicylic acid in articles of food, use an iron chloride solution, containing 0·5 grm. iron to each 100 grms. water, and having a density of 1·005 to 1·008. In the examination of butter 25 grms. of it are used with the addition of 5 c. c. of sulphuric acid, then well shaken with a definite quantity of benzol; the solution is then augmented to 100

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1 Sitzgs-Ber. Akad Wissensch., Munchen, 1882, 57.
2 Chem. Zeit., 6, 85.
3 *Ib.*, 5, 768.
4 D. Chem. Ges. Ber., 15, 467.
5 Compt. Rend., 94, 636.
6 Chem. Zeit., 6, 121.
7 Ann. Phys. Chem., 15, 297.
8 D. Chem. Ges. Ber., 15, 222.
9 Chem. Zeit., 6, 181.
10 *Ib.*, 6, 182.
11 Journ. Chem. Soc., 230, 4.
12 Compt. Rend., 94, 720.
13 Chem. Zeit., 6, 122.
14 Compt. Rend., 94, 571.
15 Journ. Chem. Soc., 230, 94.
16 Chem. Zeit., 6, 266.
17 *Ib.*, 6, 182.
18 *Ib.*, 6, 327.
19 *Ib.*, 6, 181
20 *Ib.*, 6, 267.
21 Ann. Chem., 211, 365.
22 Chem. Zeit., 6, 267.
23 *Ib.*, 6, 184.
24 *Ib.*, 6, 343.
25 *Ib.*, 6, 184.
26 *Ib.*, 6, 87.
27 *Ib.*, 6 122.
28 *Ib.*, 6, 267
29 Deut. Chem. Ges. Ber., 15, 407.
30 Chem. Zeit., 6, 267.
31 *Ib.*, 6, 184.
32 *Ib.*, 6, 86.
33 Deut. Chem Ges. Ber., 15, 447.
34 Chem. Zeit., 6, 266
35 Deut Chem. Ges. Ber., 15, 29.
36 *Ib.*, 15, 453.
37 Chem. Zeit., 6, 86.
38 *Ib.*, 6, 7.
39 *Ib.*, 6, 244.
40 Chem. News., 45, 69.
41 *Ib.*, 45, 101.
42 Chem Zeit., 6, 89.
43 *Ib.*, 6, 222.
44 *Ib.*, 6, 268.
45 *Ib.*, 6, 102.
46 Gew. Bl. Hessens, 1882, 33.
47 Chem. Zeit., 6, 223.
48 *Ib.*, 6, 89.
49 *Ib.*, 6, 88.
50 *Ib.*, 5, 3.
51 *Ib.*, 6, 88.
52 *Ib.*, 6, 161.
53 *Ib.*, 5, 118.
54 *Ib.*, 6, 268.
55 *Ib.*, 6, 87.
56 *Ib.*, 6, 241.
57 Arch. Pharm., 17, 104.
58 Chem. Zeit., 6, 123.
59 *Ib.*, 6, 89.
60 *Ib.*, 6, 88.
61 Rev. Ind., 6, 10.

c. c., and 10 c. c. of it are taken, diluted with an equal volume of water and a few drops of the iron chloride solution added. From a comparison of the intensity of color of that of a standard solution, the amount of salicylic acid present is determined. R. Kissling[62] criticises the method of Schlösing and Dragendorff for the determination of nicotine in tobacco, and recommends the following: 20 grms. cut tobacco, freed from fibers, are dried, powdered, moistened with sodium hydrate, and then extracted for two or three hours with ether in a Tollen's extraction tube apparatus; the greater proportion of the ether is distilled off and sodium hydrate added. 400 c. c. are then distilled, each 100 c. c. separately collected, and estimated volumetrically by means of sulphuric acid, with rosolic acid as an indicator. Skalweit's method for a similar purpose has been previously described.[63] To P. Degener[64] we are indebted for a methodical process for the examination of the wash water from factories.

We shall conclude by briefly alluding to some of the more important points of progress made in physiological, medical, pharmaceutical, and agricultural chemistry. E. Neusser[65] has examined, with the spectroscope, the hæmatinous urine of two persons suffering with pleuritis and tuberculosis. He observed the lines of absorption belonging to hæmaglobine, but failed to detect either blood or oxyhæmaglobin; further, he directs attention to the fact that it does not necessarily follow that every blood red liquid of the body showing the spectrum of oxyhæmaglobin is blood. E. J. Mills[66] has succeeded in extracting with water from germinating barley two albuminoids, one of which is precipitated by metaphosphoric acid at ordinary temperatures, while the other is precipitated when the liquid is boiled. Adolf Mayer[67] has studied the action of pepsin on the albumen of eggs; the digestion is a maximum at the temperature of 36° C. in the presence of 0·2 per cent. hydrochloric acid; at 55–60° the digestive power of the ferment is reduced to nothing. Prof. E. Dettmer[68] calls attention to variable effects which certain agents exert upon the cells of the living organism on the one hand, and upon ferments on the other, as, for instance, diastase. He shows that carbonic and citric acids improve the action of diastase, while the organic acids influence, in the cells of the living organism, the process of starch development. He also convinces himself that nitrogen monoxide,[69] on account of its similarity to oxygen, is detrimental to plant life. Ad. Wurtz[70] deduces from a series of experiments that when the ferments, pepsin and papain (from carica papaya), are precipitated in an insoluble state on certain albuminoids, the latter become so altered as to form at 40° regular peptones with pure water. Dr. C. Krauch[71] calls attention to the difference which exists between the normal milk of a mother and that of a wet nurse. The percentage of fat fluctuating in three cases from 2 to 6 per cent., that of milk sugar varies but little from 7 per cent. Besides the nutrition of the two persons, the different manner of their living is also an important factor. Apothecary Schneider[72] has found, on examining the purity of potassium iodide, that the French article in no way complies with the requirements of the German Pharmacopœia; an English article was examined and found to contain 2·8 per cent. metallic iron. The quality of ten German preparations was found to be, in most cases, excellent. R. Skobsberg has informed the *Chemiker Zeitung* directly that he has found iodoform to be a most precious remedy for osteotitis and diseases of the pulpa. C. Gessard[73] refers the blue and green coloration of linen bandages to a colorless organism, which precipitates the pyrocyamine described by Fordas. P. Bert[74] calls attention to the fact that in producing anæsthesia by chloroform the inhaled quantity of the latter is less important than the high percentage of anæsthetic vapor contained in the inhaled gas. The toxically effective dose of this anæsthetic is pretty near half the total one. Fr. Porrer[75] rejects the statements made in many books that morphine sulphate is soluble in two parts of water, but finds its solubility to be one in twenty-four of water. O. Hesse[76] has observed during his studies on the Argentine quebracho barks, of which the red and the blue are used as febrifuges, some six alkaloids which have a resemblance to the poisonous principles of the strychnine species. H. Bernard[77] has examined the bark of the *Celastrus scandens*, L., which is used as a febrifuge, in order to prepare a tincture to contain at least 50 per cent. alcohol, and which could be preserved. D. Howard and J. Hodgkins[78] have isolated an alkaloid of the *China cuprea*, which had previously been discovered by G. Whiffen,[79] and have named it homochinin; this is probably identical with the double salt of chinin and chinidin originally obtained by Wood and Barrett.[80] P. Chazenuve[81] has shown that birds, notwithstanding a more energetic combustion of their food at a higher temperature, produce uric acid almost exclusively instead of urea, which is the higher product of oxidation. According to the experiments made by Vulpians,[82] relative to the use of potassium permanganate as an antidote against snake bites, and recommended by Lacerda, he finds that it cannot be relied upon, that the animal becomes weak in a very few hours, and when bitten by venomous snakes is very apt to die. Prof. Plugge[83] has proved in connection with the experiments in aconitine poisoning, conducted at Winschoten, that the aconitine of commerce acts variously. That the aconitine from Petit of Paris is eight times stronger than that made by Merck, and much stronger than that of Friedländer (Trommsdorf). This statement is doubted by the *Chemiker Zeitung*, whose editor is in direct communication with these firms. Duquesnel[84] decomposes hyoscyamine sulphate by calcium carbonate, then mixes with sand, dries over sulphuric acid, pulverizes the mixture, and extracts the alkaloid with chloroform, and obtains it in stellate shaped crystals. E. Heckel and Fr. Schlagdenhauffen,[85] in examining the Icaja poison, found only strychnine and not strychnine and brucine, as did Rabuteau. According to Prof. E. Harnack,[86] the alkaloid of sassy bark, erythrophlein, is similar in its effects to nicotine and pyridine. Prof. E. Schulze and E. Engster[87] have discovered that, in addition to the albuminous bodies contained in the potato, peptones are present in very small quantities, asparagin, leucine, and pyrosine. In connection with J. Barbieri, Prof. Schulze[88] has described in a very complete manner his discovery of the occurrence of asparagin in the leaves of young trees, and also the occurrence of cholestrine in plants. The percentage of nitrogen in the form of amides, albumen nuclein in fodders, has been tabulated by W. Klingenberg.[89] His examinations were conducted in accordance with the methods of Stutzer and Fassbender. Bernard Schulze[90] has contributed a memoir to the question of the production of fat in the animal body. His results confirm the investigations of Lawes and Soxhlet, agreeing with them that carbohydrates are essential factors in the production of fat in the animal body.—*Chemiker Zeitung*, vi., 401. M. B.

[62] Zeitschrift Anal. Chem., 22, 64.
[63] Chem. Zeit., 6, 119.
[64] *Ib.*, 6, 229.
[65] Akad. Wissensch. Wien Sitzg., v., 15, Dec., 1881.
[66] Jour. Chem. Soc., 230, 33.
[67] Zeitschrift f. Biologie, 17, 351.
[68] Sitzgs. Ber. Gew. Ges., 1881, 5 and 22.
[69] Chem. Zeit., 6, 224.
[70] Compt. Rend., 93, 1104.
[71] Chem. Zeit., 6, 244.
[72] Arch. Pharm., 17, 39.
[73] Chem. Zeit., 6, 233.
[74] Jour. Pharm. Chim., 5, 16.
[75] Am. Jour. Phar., 54, 97.
[76] Ann. Chem., 211, 249.
[77] Chem. Zeit., 6, 124.
[78] Jour Chem. Soc., 231, 66.
[79] Chem. Zeit., 6, 8.
[80] *Ib.*, 6, 68
[81] Compt. Rend., 93, 1155.
[82] *Ib.*, 94, 613.
[83] Arch. Pharm., 17, 20.
[84] Chem. Zeit., 6, 134.
[85] Jour. Phys. Chim., 5, 34.
[86] C. B. f. Medecin Wissensch., 1882, 145.
[87] Landw. Vers-Stat., 27, 357.
[88] Jour. Prakt. Chem., 1882, 145.
[89] Chem. Zeit., 6, 124.
[90] *Ib.*, 6, 27.

EXAMINATIONS OF VARIOUS ARTICLES CARRIED OUT BY STUDENTS IN THE CHEMICAL LABORATORY OF RUTGERS COLLEGE, AND THE NEW JERSEY STATE SCIENTIFIC SCHOOL, UNDER THE DIRECTION OF PROF. PETER T. AUSTEN, PH.D., F.C.S.

AN EXAMINATION OF VINEGARS.

By FRANKLIN MARSH, B.S.

Adulterations.—The principal foreign substances with which vinegar is adulterated are sulphuric, sulphurous, hydrochloric, nitric, tartaric, and oxalic acids. In certain cases lead and copper have been found in vinegars that have stood in vessels made of those metals. In England the strongest kind of malt vinegar manufactured is termed "proof vinegar," and contains five per cent. of acetic acid. It almost always contains a certain amount of sulphuric acid, for the law allows the manufacturers to add the one-thousandth part of this acid, this addition being supposed to make the vinegar keep better. A properly made vinegar, however, does not need to be thus protected.

The most common and most dangerous adulterant of vinegar is sulphuric acid. During the past month I have examined fifty samples of vinegars bought in the stores of New Brunswick and Rahway. Forty-two of the samples I purchased in New Brunswick. I examined the lot for sulphuric acid, and I will state that in only one did I find more than a minute trace of sulphates, and in none could I detect any free sulphuric acid.

The samples were first tested with a solution of barium chloride, which gives a white precipitate with sulphuric acid and sulphates. As a test for free sulphuric acid, the vinegar was evaporated to dryness with some cane sugar. If free sulphuric acid is present the mass becomes black, owing to the charring of the sugar by the acid.

I also determined the specific gravity by the hydrometer, and found that they varied from 1·0075 to 1·03; those of the lowest specific gravity coming from the cheaper and smaller grocery stores, as a general thing. In color they varied from colorless to dark brown, some being clear, others murky and thick.

From my examination I can state that the vinegars sold in New Brunswick are free from sulphuric acid or other dangerous adulterants.

AN EXAMINATION OF CERTAIN JAPANESE BRONZES.

By JUGOI TADNARI MATSDAIRA, B.S.

Bronze, as is well known, is an alloy of copper and tin. The relative amounts of its constituents vary according to the purpose for which it is intended; sometimes lead, zinc, gold, and silver are added, with the intention of giving it greater brilliancy or fusibility. Modern bronzes differ from the antique ones in composition and manner of manufacture. The bronze coin of Alexander the Great (335 B.C.) contained 86·72 per cent. of copper and 13·14 per cent. of tin. A Roman bronze coin (500 B.C.) contained 66·04 per cent. of copper, 7·66 per cent. of tin, and 29·32 per cent of lead. Many of the modern French bronzes are composed of—

Copper	91 parts.
Tin	2 "
Zinc	6 "
Lead	1 "
	100 "

The Japanese word corresponding to bronze is "karakane," meaning Chinese metal. Brass is called "shin-chu." The bronze industry in Japan is very ancient. Copper has been produced in Japan since the eighth century, but even before that period the manufacture of bronze had reached a certain stage of perfection, the copper or its alloys having been imported from China. Giyoka, a priest, and the introducer of the potter's wheel, planned the erection of monster statues to the god Buddha, and the plan was carried into execution by the Emperor Shomw, in 724–749 A.D. Three of these statues still exist. They are about fifty feet in height, and are said to contain a small percentage of gold.

The modern bronze castings are employed for many useful and ornamental purposes, such as statues, bells, vases, knife-sheaths, candlesticks, etc., and are generally made in the simple and curious style of the old and celebrated Chinese bronzes, or are embellished with the characteristically grotesque vagaries of Japanese art.

The bronze objects are cast in clay moulds, formed upon models made of a mixture of wax and resin, which is melted and poured out of the mould previous to running the metal in. The melting furnaces are generally of small dimensions, and consist of an iron pot lined with clay.

The surface of the casting is then finished, and the design corrected by chiseling. Frequently gold and silver are inlaid to produce artistic effects. This work is known as "zogan," and is principally carried on in the provinces of Kagan and Techin. Frequently the surface of the bronze is deadened and darkened by the application of a solution of sulphate of iron and other chemicals.

I have examined two of the best known kinds of bronze. One is called "shibuich." Its surface is of a light, brilliant gray color, but a scratch reveals a red metal. The object from which I took the sample for analysis was a knife-sheath. The analysis gave—

Copper	74·11 per cent.
Silver	25 81 "
	99·92 "

The other sample was also from a knife-sheath, and was the metal known as "shakudo." The surface was a dark rich brown. It contained—

Copper	98·95 per cent
Silver	·63 "
Iron	·05 "
	99 63

THE WELL WATERS OF NEW BRUNSWICK.

By CONDICT W. CUTLER, B.S.

The analysis of well water is as much, if not more important than that of the "city supply," for it is the well water that is generally used for drinking and domestic purposes.

Although well-water is so frequently used in preference to that of the "city supply," still it is often by far the most impure, though it may be clear and sparkling. Well-waters may become contaminated in many different ways. The most frequent, perhaps, is the tendency for a well to act as as drain for the ground in its vicinity.

A well may be considered as a perpendicular drain, and a such we can readily perceive that it becomes a receptacle for all surface-water in its vicinity. One might suppose that a well dug in a sandy soil or clayey soil would be thus subject to impurities, but when constructed through rock or shale it would be entirely free from such contamination. This, however, is not always the case, for although rock may form some protection, still impure waters are often found in wells built entirely through stone.

A well in Montclair, N. J., was contaminated from a cesspool sixty feet distant. As the first few feet of the well was constructed through sandy soil, while the remainder ran through red sandstone, it was thought, of course, that the impurities worked their way in through the sand, thus spoiling the water for use. Consequently, that part of the well, down to the sandstone, was masoned up, and a coat of hydraulic cement applied to its outer surface. As no benefit followed, three investigations were made, resulting in the discovery that the water from the cesspool, sixty feet distant, had worked its way through the cracks of the red sandstone into the well.

Another curious result followed from this investigation, viz., the water drawn from the surface of the well was quite pure, while that drawn from the bottom was greatly contaminated, showing that good and bad waters may exist in a well at the same time, owing to the difference in their specific gravities.

Although the soil in which cesspools are dug may be able to retain the sewage for a long time, still the ground gradually becomes saturated, and, acting as a sponge, the impure water is carried for many yards until, perhaps, it strikes a well into which it may drain.

Persons living on high ground may suppose their wells to be free from such impurities, not knowing that the barnyard or cesspool may be one of the springs from which their water is obtained.

Wells constructed in the usual manner are particularly apt to contain bad water—first, from drainage, as I have just illustrated; and secondly, from the decay of animals or reptiles which have fallen in them. The stones lining the wells are so rudely put together that ample room is allowed for toads, snakes, snails, etc., to collect, and hence frequently fall into the water and perish. It is stated by well-diggers that generally they find, at the bottoms of old wells, eight to sixteen inches of mud, containing the decaying *débris* of these unfortunate creatures. It is therefore of the utmost importance that wells be so constructed that the water may be as free as possible from all drainage and contamination caused by the decay of small animals.

A gentleman recently informed me that he had, for many years, allowed the sewage from his house to flow into an old well. As this well has never filled, the sewage must pass on with the vein of water, which, in all probability, supplies other wells in the vicinity, from which persons are using the water, little imagining what the strange water supply is, which helps feed their wells.

Is is almost impossible to construct a well from which water, known to be absolutely pure, can be obtained. Hence, an analysis of well-water is of much importance as the only method of establishing the purity of the water.

The method of analysis used in the following determinations was the one known as Wanklyn's. A portion of the water is partly distilled. The first portion of the distillate contains nearly all the free ammonia existing in the water. This free ammonia is estimated by "Nesslerizing." The residual water is then treated with a mixture of caustic potash and potassium permanganate and again distilled. The distillates contain the ammonia which was in the albuminoid form, and which is also estimated by "Nesslerizing." Lastly, the chlorine and total solid residue are determined.

The following points will serve to make the results in the table of analyses explicable:

1. Alb. am. alone over 0·1 is suspicious.
2. Free am. alone over 0·1 indicates nothing.
3. Chlorine alone, 5–10 grains, indicates nothing.
4. Total solids alone, over 40 grains—very suspicious.
5. Alb. am. over 0·10, plus free am. over 0·08—suspicious.
6. Alb. am. over 0·10, plus chlorine over 10 grains—bad.
7. Alb. am. over 0·10, plus solids over 40 grains—bad.
8. Free am. over 0 08, plus chlorine over 10 grains—suspicious.
9. Free am. over 0·08, plus solids over 40 grains—suspicious.
10. Chlorine over 10 grains, plus solids over 40 grains—suspicious.
11. Alb. am. over 0·1, plus free am. over 0·08, plus chlorine over 10 grains—bad.
12. Alb. am. over 0·1, plus free am. over 0·08, plus solids over 40 grains—bad.
13. Alb. am. over 0·1, plus chlorine over 10 grains, plus solids over 40 grains—bad.
14. Free am. over 0·08, plus chlorine over 10 grains, plus solids over 40 grains—bad.

If a water contain over forty grains of solid matter to the gallon, it is generally injurious to health. Such an amount is always suspicious, and demands investigation to ascertain if the matter is organic or inorganic.

When little chlorine is found and albuminoid ammonia is large, vegetable contamination is indicated, but if chlorine is also present, animal impurity is shown.

If much chlorine is found there is reason to suspect the presence of sewage contamination.

Although vegetable impurities do not seem to be as harmful as those of animal origin, still, water containing such contaminations should not be used for domestic purposes, if it can be avoided.

LOCATION OF NEW BRUNSWICK WELLS.	Solid Residue, in grains, per gallon.	Chlorine, in grains, per gallon.	Free Ammonia, in parts, per million.	Albuminoid Ammonia, in parts, per million.	Date of Collection.
1. College Av., opposite the Grammar School	35·56	3·9	0·032	0·070	Mar. 17
2. Corner George and Paterson Sts.	39·64	3·50	0·000	0·06	19
3. Albany St., opposite Masonic Hall	34·39	3·09	0·000	0·12	20
4. Corner Church and French Sts.	27·57	3·90	0·052	0·086	21
5. Church St., opposite Morgan and Shivler	36·14	4·25	0·324	0·130	24
6. Somerset St., near Washington	38·82	5·83	0·066	0·154	26
7. Foot of Albany St.	62·97	11·13	0·064	0·076	May 2
8. Foot of Schureman St., on Burnet	48·68	8·74	0·60	0·172	6
9. John St, near Carman	46·64	6·47	0·016	0·250	8
10. John St., between Hassert and Oliver	17·49	1·98	0·002	0·040	8
11. Corner of Oliver and Neilson Sts.	33·81	4·66	0·002	0·100	8
12. Corner of New and Neilson Sts.	59·00	6·10	0·112	0·210	9
13. Between George and Neilson Sts., on Schureman	54·53	6·66	0·024	0·230	9
14. Corner of Neilson and Liberty Sts.	66·92	6·06	0·080	0·206	15
15. Corner of Neilson and Bayard Sts.	37·31	5·24	0·004	0·146	3
16. Corner of Neilson and Paterson Sts.	29·38	1·10	0·106	0·380	10
17. Somerset St., between Water and Neilson	79·28	13·41	0·010	0·280	2
18. Water St., under Penna. R. R.	202·31	7·98	0·014	0·192	1
19. Court House grounds	14·69	1·15	0·008	0·070	19
20. Corner of New and Schuyler Sts.	27·98	3·60	0·016	0·086	20
21. Livingston Av., corner of George St.	27·28	3·38	0·008	0·024	16
22. Corner of George and Morris Sts.	11·16	1·34	0·002	0·056	17
23. George St., between Commercial and Throop Avs.	33·81	4·50	0·026	0·146	23
24. Welton St., between Remsen and Livingston Avs.	38·24	4·60	0·020	0·400	19

Good waters—Nos. 1, 2, 4, 10, 19, 20, 21, 22.
Fair waters—Nos. 3, 11.
Bad waters—Nos. 5, 6, 7, 8, 9, 12, 13, 14, 15, 16, 17, 18, 23, 24.

"EXAMINATION OF SUGARS."

By W. D. SCHOONMAKER, B.S.

Of late, chloride of tin has been used for coagulating, instead of albumen. Considerable attention has already been drawn to this fact by chemists, and not long ago many sugars sold in the city of New York were found to contain salts of tin. Not more than a year ago a patent was taken out in Germany for the use of nitrate of zinc for the same purpose. To determine whether the sugars sold in New Brunswick also contained deleterious substances, eighty samples were purchased from the various dealers, and tested for tin and zinc. In no case, however, was a trace of either of these metals to be found.

"ANALYSES OF 'SPIEGELEISEN.'"

By C. M. FREEMAN, B.S.*

"Spiegeleisen" is a German word, and signifies looking-glass iron, from its peculiar luster. It is now used to designate all pig-iron which contains enough manganese to give it the luster peculiar to spiegeleisen. Manganese was first introduced into the steel manufacture by Heath, who discovered that the use of one to three per cent. of it, or materials producing it, made sound cast-steel out of blistered steel from cheap British bar. It is made in a blast furnace. The following tables show the proportions of some of the materials in various charges, used at the spiegel furnace of the Oxford Iron Works, and were kindly furnished by Mr. Wm. H. Scranton:

	1	2	3
No. of pounds of iron ore	500	720	260
" " manganese ore	500	280	370
" " limestone	200	170	370
" " coal	1,000	1,000	1,000
No. of tons of spiegel in 24 hours	7	7	8
Per cent. of manganese in spiegel	30	28	20
Pressure of air blast	4	4	4
Temperature of blast	800	800	800

Percentage of iron and manganese in iron ore, 12 p. c. of iron, 11 p. c. of Mn.

Percentage of iron and manganese in manganese ore, 23 p. c. of iron, 21 p. c. of Mn.

"EXAMINATION OF KEROSENE."

By F. A. CHAPMAN, B.S.

Kerosene is the most important product of petroleum. It has a burning taste and an aromatic odor. When properly refined, it is nearly colorless. Its density should be about 43° B. At ordinary temperatures, it should extinguish a lighted match as readily as water. When heated it should not evolve vapor below 110° F., and should not take fire below 125° F. As the temperature of a burning lamp rarely exceeds 100° F., it would then be perfectly safe. The crude naphtha sells from two to three cents a gallon, while kerosene sells from sixteen to twenty-five cents per gallon. A great competition necessarily exists among the refiners, and thus there is a great temptation to run off the heavier parts of the naphtha into the kerosene tanks, thus getting the price of kerosene for it. They change the stream at about 63° B. instead of at 58° B., and the highly inflammable naphtha is allowed to mix with the kerosene, rendering the whole dangerous. Dr D. B. White found that experimenting on an oil that flashed at 113° F., adding one per cent of naphtha caused it to flash at 103° F.; 10 per cent. of naphtha caused it to flash at 59° F., and to burn at 50°. Thus it is the cupidity of the refiner that leads him to mix the highly inflammable naphtha with the kerosene, causing many frightful explosions.

A section in the internal revenue act of March 2, 1867, relates to the subject of dangerous kerosenes. It reads as follows: Sec. 29. And be it further enacted, that no person shall mix for sale naphtha and illuminating oil, or shall knowingly sell, or keep for sale, oil made from petroleum for illuminating purposes, inflammable at less temperature or fire-test than 110° F. And any person so doing shall be held guilty of a misdemeanor, and on conviction by indictment, or presentment, shall be punished by a fine of not less than $100, nor more than $500, and by imprisonment for a term not less than six months, nor more than three years.

This was decided by the Supreme Court to have no effect within the several States themselves. The following States have passed laws for the regulation of the sale of petroleum oils: Maine in 1867, Vermont in 1868, Massachusetts in 1868, Pennsylvania in 1865, Rhode Island in 1871, Maryland in 1871, Ohio in 1867, Illinois in 1869, Indiana in 1863, Georgia in 1870, Michigan in 1869, Missouri in 1870, Louisiana in 1870, New York City in 1865. We see by this that New Jersey* has no laws in regard to the sales of petroleum, etc.; neither have we any municipal ordinances in New Brunswick.

Thirty-five samples of oils purchased in various stores in New Brunswick were tested by the Tagliabue open tester. Out of these thirty-five, only five flashed above 110° F., and only nine above 100° F., all the remainder being below this, or in other words, between 74 and 75 per cent. of the oils tested were what may be called highly dangerous oils.

The results prove that there are but few oils sold in the city of New Brunswick which are in any way safe Almost every day we hear of the most horrible accidents occasioned from the explosion of lamps filled with what is sold as kerosene, but which might as well be called nitroglycerine. We hear of women and children dying in unutterable tortures, of conflagrations destroying thousands of dollars of valuable property, and yet no steps seem to be taken to legally restrict the shameful and criminal cupidity which instigates tradesmen to swindle the public and endanger the lives of our citizens, or to allot a proper punishment to those who succeed in murdering their customers.

* Mr. Freeman was for some time employed as chemist to the Oxford Iron Works.

* Since this was written a law has been passed on the matter.

CREAM OF TARTAR.

By JOHN BRUERE, B.S.

Cream of tartar, or more properly, hydrogen potassium tartrate, exists naturally in the juice of the grape, being held in solution by the saccharine matters present. It is, however, insoluble in alcohol. Hence, as the sugar of the grape juice is gradually converted into alcohol by fermentation, it is deposited. In the crude form it is known as argol, and is dark red and impure. When pure, it is called cream of tartar, and is then pulverulent, having a gritty feel and a pleasant acid taste.

A ton of grapes yield, according to the nature of the fruit, from one to two pounds of argol, which in good samples affords an average of 83 per cent, of cream of tartar. Argol is an article of export from the wine-producing countries. The best comes from Italy and Southern France. It is used as a source of tartaric acid, and the various tartrates used in medicine and the arts. The cream of tartar of commerce is rarely perfectly pure, generally containing a small percentage of calcium tartrate. In the arts, argol is used as a source of soluble tartrates, rochelle salts, tartar emetic, tartarized iron, and salts of tartar. In the pure state it is used in medicine as a cathartic, refrigerant, diuretic, and aperient.

Cream of tartar is largely used in the household for raising bread and cake. When mixed with bicarbonate of soda and mingled with the dough, a chemical reaction takes place, forming sodium potassium tartrate, rochelle salts, and carbonic acid. The latter, which is slowly evolved, inflates the dough and renders it porous and light.

Cream of tartar being a white powder rather difficultly soluble in water, can easily be adulterated with any article of a like nature and color. For this purpose it has been stated that sawdust, clay, gypsum, flour, chalk, alum, and potassium sulphate have been used. The article has been examined at various times, and almost always found to be more or less adulterated.

ALKALIES IN SILVER NITRATE.—The salt is dissolved in the smallest possible quantity of water; the liquid is filtered, and hydrofluosilicic acid is added drop by drop. If this produces a turbidity, an alkaline salt is present. If the liquid remains limpid, it is mixed with an equal volume of alcohol, which will precipitate the slightest traces of alkali if present. —*M. Stolba, in Journal de Pharmacie et de Chimie.*

ANALYSIS OF EXPLOSIVES THAT CONTAIN NITROGLYCERINE.

By F. HESS.

THE explosive constituents of these substances are nitroglycerine, gun cotton (highly nitrated), collodion cotton (of low nitration), and nitrated wood. The absorbents that take no part in the explosion are infusorial earth, randanite, tripoli, clay, and alumina. Mineral absorbents that take some chemical part in the explosion are all such as can give out a volatile substance under the influence of heat, like chalk and carbonate of magnesia. Of organic absorbents the ones chiefly employed are sawdust, wood fiber (paper stock), charcoal, brown coal, and stone coal. Among the oxygenated mineral substances used are saltpeter, soda saltpeter, nitrate of ammonia, and nitrate of baryta, while chlorates have as yet been rarely introduced. (Séranine and Horsley powder contain chlorate of potash and nitroglycerine.) Basic substances are added to increase their chemical stability, mostly carbonates of alkalies or alkaline earths, like the carbonates of soda, ammonia, lime, or magnesia. The two last named often serve at the same time as absorbents. Paraffine, sulphur, rosin, and other substances serve in part to protect the absorbents from moisture in case they are hygroscopic, and in part to adapt their absorptivity to the nitroglycerine. Other additions, like colcothar, are merely to change the color. In many cases camphor is used to decrease the sensitiveness of nitroglycerine to mechanical and calorific influences.

QUALITATIVE ANALYSIS.

The substance must be as finely divided as possible by crushing and mashing it on a horn plate with a horn spatula, if plastic; or cutting it in fine strips with a horn knife, if gelatinous. If pulverulent it can be easily broken up. It is first treated with anhydrous ether, if plastic or pulverulent; or with a mixture of two parts ether and one of absolute alcohol, if gelatinous. In the former case the nitroglycerine will be dissolved out, and paraffine, sulphur, rosin, and camphor, if they are present. In the latter case the collodion cotton, or other less nitrated cellulose, will also be dissolved. The ethereal extract is freed from ether on a water bath at 30° C. (86° F.). To recognize the presence of nitroglycerine as such, a drop of the oil that remains is taken out on a piece of filtering paper, and struck with a hammer on an anvil, when it should explode. The oil dissolved in alcohol is treated with an aqueous solution of ammonium sulphide, which at first forms polysulphurets, and then sulphur separates. A drop of the oil put in a solution of ferrous sulphate, acidified with hydrochloric acid, gives the nitric oxide reaction on warming. One drop put in a starch and iodide of potassim solution containing a few zinc filings, and acidified with very dilute sulphuric acid, colors the liquid blue. If the oily residue from the ethereal extract seems homogeneous, its specific gravity can be taken. If it is about 1·6, and it has no particular odor, we may assume that it is only nitroglycerine. If sulphur, paraffine, or rosin are present in any quantity, they separate from the nitroglycerine on the evaporation of the ether. The sulphur can be recognized by its crystals and the smell on burning. To test it some of the substance is pressed between filter paper and burned. Paraffine remains when cold alcohol is added to the extract freed from ether, and can be freed from adhering liquid by pressing on filter paper, and further tested by its boiling and melting points and the smell of the products of distillation. Rosin can be saponified by boiling with soda lye, and isolated by precipitating it with hydrochloric acid. The presence of sulphur, paraffine, and rosin, or any two of these in one and the same explosive, is not to be expected from the results of the experiments made so far. But if the appearance of the dry extract is such as to lead to the suspicion that more than one is present, the nitroglycerine is decanted and the residue pressed between filtering paper as long as it greases it. The rosin is removed by boiling with soda lye, and the residue washed and dried. A part of it is treated with aqua regia to convert any sulphur into sulphuric acid, and then tested with barium; another part is boiled with ammonium sulphide, which dissolves sulphur to form a polysulphide. When cold the paraffine will form a crust on the liquid, and can be washed, dried, and submitted to other tests. If it contains camphor, too, it can be distinctly recognized by the smell.

If a mixture of alcohol and ether is used, instead of ether alone, to extract the subtance, the mono and dinitrocellulose (collodion cotton) is first precipitated with chloroform and pressed out. The solution is then heated to 30° C. and afterward to 80° C. (176° Fahr.) to expel all the alcohol, ether, and chloroform, and then treated as above indicated. The nitrocellulose will be recognized by its combustibility, by exploding when struck, and by dissolving when boiled in sodium sulphide solution. When boiled with hydrochloric acid and ferrous sulphate it should give the nitric oxide reaction.

The residue of the explosive insoluble in ether is next extracted with hot distilled water, when the nitrates, chlorates, and soluble carbonates go into solution, as also extractive matters from the organic matters. If the first extraction was with ether alone, the residue may contain mono, di, or trinitro-cellulose, but if it was made with alcohol and ether, only trinitro-cellulose will be present with the other substances insoluble in water, alcohol, and ether. If mono and dinitro-cellulose are suspected it is treated with alcohol and ether as before. The presence of trinitro-cellulose is found by examining the residue under the microscope with polarized light. Trinitro-cellulose exhibits the plant structure of the substance it was made from, but it has a dull appearance, while unchanged cellulose exhibits a brilliant play of colors. On boiling with hydrochloric acid and ferrous sulphate it must give the nitric oxide reaction. On boiling the residue with alcoholic potash, and acidifying the filtrate slightly with sulphuric acid, free nitric or nitrous acid will be found. When trinitrocellulose has been detected it can be removed by boiling the residue with sodium sulphide solution, filtering and washing with distilled water. The bases that have gone into solution and the carbonic acid liberated during solution are detected by the usual tests, but the residue must be examined microscopically. Sawdust, wood fiber, and charcoal can be easily recognized by the color and structure. After burning it the mineral substances can be detected as usual.

ESTIMATION OF NITROGLYCERINE.

In almost all cases the substance is first extracted with ether. This is better than wood spirits, alcohol, chloroform, and other extracting substances, because it evaporates so rapidly, and it leaves behind most of the other constituents.

The moisture is estimated first by drying it over chloride of calcium. Sulphuric acid should not be used in the desiccator, as it may spatter and cause an explosion. The explosive may be extracted in a closed funnel on a dried and weighed filter, or in a continuous extracting apparatus on such a filter. In the former case care must be taken that the volatile liquid does not rise too high on the sides of the vessel and cause loss of nitroglycerine. The ethereal extract is put in a small weighed beaker, and evaporated on a water bath at a very gentle heat. During the evaporation at a certain point the liquid gets milky as the nitroglycerine begins to separate. From now on, the operation must be watched, and as soon as the turbidity vanishes again, the beaker must be immediately removed from the water-bath. The nitroglycerine still contains a little ether or acetic ether. To remove these and traces of water it is dried in an air-pump receiver over chloride of calcium. The nitroglycerine can be weighed as pure when it has no more smell of ether, acetic ether, etc., and there is no perceptible difference in two successive weighings. If it contains other substances, like paraffine, rosin, and sulphur, which are soluble in ether, they are extracted along with the nitroglycerine, but to avoid using too much ether and a consequent loss of nitroglycerine in evaporating it, apparatus for continual extraction are used. After the ether evaporates the residue is dried and weighed, then warmed with soda lye on the water-bath. The rosin is dissolved and can be removed by decanting and washing with distilled water. It is precipitated again with hydrochloric acid, collected on a tared filter, washed, dried at 100° C., and weighed. Then the nitroglycerine is taken up with strong alcohol, decanted, and the residue of paraffine and sulphur rinsed with strong alcohol, dried, and weighed. To separate the sulphur and paraffine the mixture is warmed with an aqueous solution of ammonium sulphide, allowed to cool, the film of paraffine broken through, solution decanted, and paraffine washed, dried, and weighed—the quantity of nitroglycerine and of sulphur found by difference. In gelatinous explosives which contain mono or dinitro-cellulose, the extraction with ether will go on very slowly, because the dissolving of the nitroglycerine leaves a pellicle of collodion which protects the rest from solution. In this case it is better to extract both cotton and nitroglycerine at the same time with alcohol and ether, and then precipitate the cotton with chloroform. If camphor is also present, which can only be added to a few of the gelatinous ones, it must be extracted with carbon disulphide from the residue, freed from ether and chloroform. Camphor has never yet been found in the same mixture with paraffine, sulphur, or rosin. If they should be present all together they would be extracted along with the camphor by the disulphide, and can be separated from the others by its volatility. In the residue, after extraction with ether, or alcohol and ether, there may be trinitro-cellulose, or any one or more of the other substances already mentioned. If the qualitative analysis showed that the residue consisted only of mineral substances, it can be burned with the filter and weighed. It is better, however, to dry it first in a current of air at 60° C. (140° Fahr.), and weigh it and then burn it, and thus ascertain if there is not a little organic matter left in the residue: If there are any soluble salts in it they can be extracted with hot water after the weight of the dry residue has been found, and by evaporating their solution and drying at 120° C. their total weight is taken along with any extractive matter also present. If there are any carbonates, but no chlorates, the dry salts are dissolved in water neutralized with nitric acid, and evaporated on a water-bath, dried at 120° C. and weighed again. The carbonates are converted into nitrates, and the amount of carbonic acid calculated from the difference in weight. If the mass is ignited, then moistened when cold with nitric acid, and freed from the excess of acid, the salts will be converted into nitrates, but the extractive matter destroyed.

If, however, there are chlorates present, part of the salt must be ignited to convert them into chlorides and then estimated as chlorides of silver, the carbonic acid having been estimated by precipitation with nitrate of lime. The nitric acid can be estimated in another portion of the extract by conversion into ammonia. After estimating the bases in a separate portion, the extractive can be found by difference.

The residue insoluble in water is treated as follows: If it contains trinitrocellulose, a portion is removed from the filter and boiled with quite a concentrated solution of sodium sulphide, which dissolves the nitrocellulose; the rest is collected on a weighed filter, washed carefully with distilled water, dried, and weighed. The loss of weight gives the proportion of nitrocellulose in the part taken, and is calculated to the whole. After the trinitrocellulose is removed, or if there is none there, the rest is treated with dilute hydrochloric acid to remove any carbonate of lime or magnesia (also alumina), and these bases estimated in the solution. The residue is washed, dried, and weighed. This residue contains the wood, charcoal, or similar organic substances, and the insoluble mineral absorbents. The organic constituents are removed by burning, and the insoluble mineral matter weighed, and eventually separated and estimated in the usual way. If there is more than one organic absorbent used, as wood fiber and charcoal, there is no satisfactory method for separating them, and we must be satisfied with an elementary analysis, and judge of the substances by the relative proportions of carbon and hydrogen.

As a rule it is necessary to separate the proximate constituents. It is only in those dynamites that contain no other substance beside nitroglycerine that would affect its estimation, like Nobel's infusorial dynamite, in which a nitrogen determination can be made as proposed by Hempel, and a commercial valuation based on it, expressed in the calculated quantity of trinitrine. Although there is no longer much variation in the properties of the "oil," it has been found from the experiments made by a military commission that even in so simple a form of dynamite as Nobel's, the explosive value does not always increase and decrease in the same proportion as the percentage of nitroglycerine. The physical relations play a part in the simplest dynamites as well as the chemical composition. Among these are the more or less perfect absorption of the oil by the absorbent, from the adhesion of the particles together, on the elasticity of the preparation (in those containing gelatine), and on other similar circumstances. A nitroglycerine explosive of correct theoretical composition will be more or less completely used up by detonation, and its true effect more or less perfectly developed, in proportion as it is in the proper physical condition. Indeed, under certain circumstances a dynamite that is poor in nitroglycerine will produce more effect in the same medium than a fatter one having otherwise the same composition. To determine the explosive value of a dynamite in this respect, and thereby establish its commercial value, the chemical analysis must be supplemented by suitable means of ascertaining, by direct experiments on a small scale, the explosive value of the preparation in practical use.

Hempel's method of estimating nitroglycerine, above referred to, consists in shaking a mixture of dynamite and sulphuric acid with mercury and measuring the volume of nitric oxide evolved. If nitrates, carbonates, and nitrocellulose are present, the separation of nitroglycerine may first be made by the process above described so as to avoid error.

APPARATUS FOR THE ESTIMATION OF SULPHUR IN SPENT OXIDE.

By H. LEICESTER GREVILLE, F.I.C., F.C.S.

I HAVE lately been using for estimating the sulphur in spent oxide an apparatus which I have found very convenient. It is shown in the annexed illustration, and a description of it, together with an account of the mode of using it, may possibly be of interest to some of the readers of the *Journal*.

Referring to the diagram, B is a Hoxeth's fat extraction tube, fitted by caoutchouc stoppers at its lower extremity to a 10 oz. flask, F, and at its upper extremity to the condenser, A, by means of a bent glass tube, with flexible rubber joint. The condenser should be about two feet in length. G is a small circular tin vessel provided with an annular rim on the inside about an inch down, on which the bottom of the flask, F, rests. In using the apparatus, the charge of oxide, which may be from 100 to 200 grains, is placed in the tube, C, which is simply a short piece of ordinary test-tube, the bottom of which is contracted without being sealed. To charge this tube, the bottom is loosely plugged with tow, the weighed quantity of oxide then introduced, followed by a further plug of tow, leaving a small space unfilled at the top of the tube. The tube with its charge of oxide is then placed in the Hoxeth's tube, B, and four or five ounces of carbon disulphide poured in. The liquid will flow into the flask, F, by the siphon, D. The caoutchouc stopper of the Hoxeth tube, B, is then inserted (connection being thus made to the condenser), and the apparatus is ready for use.

On sending a current of steam from a flask of boiling water, or from some other source, into the tin vessel, G, the carbon disulphide soon boils, and the vapor passes up the tube, E, and becoming condensed on passing into A, the condensed liquid runs back, falling in drops into and filtering through the oxide in C. After a short time the tube, B, becomes filled up to the level of the top of the siphon, D, which then starts into action the solution of sulphur which has been formed, running into the flask, F. This ac-

tion of filling and discharging continues automatically until the whole of the sulphur has been transferred from the oxide to the carbon disulphide in the flask, F. The fact of the extraction being complete may be known by the liquid which periodically siphons off being practically colorless. By lowering the condenser, A, into the position shown by the dotted line, H, the carbon disulphide may now be distilled off, leaving the sulphur in the flask, F, in the solid state; the final drying being accomplished in a current of warm air or in the air bath. If the weight of the flask, F, is known, the increase in weight after the completion of the experiment gives the amount of sulphur. The small bent tube at the end of the condenser is for the purpose of preventing the escape of the heavy carbon disulphide vapor during distillation, at the same time that the liquid has a free exit.

The great convenience of this apparatus lies in its requiring so little attention. The extraction of the sulphur takes place completely and automatically, and the operator is enabled to devote himself to other work while the sulphur estimation is progressing.—*The Journal of Gas Lighting.*

ASBESTOS.

ASBESTOS is a mineral having a texture more or less filamentous, and by trituration is reducible to a somewhat fibrous powder. It is commonly divided into four varieties.

1. *Amianthus or Mountain Flax.*—The usual color of this mineral is greenish white, passing into leek green; or silver white, yellowish white, ocher yellow, pale flesh red, and, very rarely, light blue. It is found sometimes in small separate bundles, but more usually in irregular fibrous masses. Its luster is glimmering or slightly shining, and is either weak, pearly, or silky. It is easily divisible into long slender flexible fibers, may be scratched by the nail, and has a soft somewhat greasy feel. It is generally opaque, but is sometimes translucid on the edges. Its specific gravity is subject to great variety; that of the most flexible and perfectly fibrous is only 0·908; that of the most compact is 2·313.

According to an analysis of this mineral by Chenevix, it appears to contain: 25 magnesia; 59 silex; 3 alumina; 9·25 lime, and 2·25 oxide of iron.

Before the blowpipe amianthus melts with some difficulty into an opaque globule, which becomes dark colored by the continued action of the flame. If exposed to a high heat in an earthen crucible, it melts into a dense slag, strongly adhering to the vessel and of a yellowish gray color; the surface of this slag is overspread with crystalline needles, crossing each other in all directions, or radiating from a common center. If the heat is considerably increased, the whole melts into a green glass and in a short time passes through the crucible. A specimen of amianthus from Greenland, being inclosed by Klaproth in a charcoal crucible and exposed to the full heat of a porcelain furnace, fused into a finely porous mass of a dirty pearl gray color, covered externally with grains of iron.

This mineral is met with in potstone or serpentine rocks, either dispersed through them or accumulated in their clefts and crevices, unmixed with any other substance. The most beautiful comes from the Tarentaise in Savoy; it is in white flexible filaments, sometimes a foot long, of a pure silk luster. In some parts of Corsica it is so common as to have been used by Dolomieu instead of hay or moss, to pack up specimens of other minerals in. The islands of Elba and Crete; Zoblitz in Saxony; Stuartwick in Sweden; Cornwall and Anglesea in England, and Portsoy in Scotland, also furnish considerable quantities. A compact kind, which decomposes by exposure to the air into remarkably flexible threads, is found in the Ural mountains in Siberia. Amianthus is also found in great abundance in a few localities in the United States.

The fibrous texture of amianthus, its incombustibility, and the little alteration that it undergoes even in a strong heat, were early noticed, especially among the Eastern nations; and methods were found out of drawing the fibers into thread and afterward weaving it into cloth. This, when dirtied with grease or other inflammable matter, was cleaned by throwing it into a bright fire; the stains were burnt out, and the cloth was then removed, but little altered in its properties, and of a dazzling white. In the rich and luxurious times of the Roman Empire this incombustible cloth was purchased at an enormous price for the purpose of wrapping up the bodies of the dead previous to their being laid in the funeral pile. The practice of burning the dead falling into disuse, occasioned the manufacture of amianthine cloth to be neglected, and at length entirely forgotten in Europe; but though it ceased to be an article of luxury or necessity, yet the method of its preparation attracted the notice of travelers and occupied the time of the curious. Ciampini, of Rome, in 1691 gave the following method of preparing incombustible cloth: Having previously steeped the amianthus in warm water, divide its fibers by gently rubbing them with the fingers, so as to loosen and separate all the extraneous matter; then pour on repeatedly very hot water as long as it continues to be in the least discolored. Nothing will be now left but the long fibers, which are to be carefully dried in the sun. The bundles of thread are to be carded with very fine cards, and the long filaments thus obtained are to be steeped in oil, to render them more flexible. A small quantity of cotton or wool is to be mixed, and by means of a thin spindle the whole is to be drawn out into thread, taking care that in every part the amianthus may be the principal material. The cloth being then woven in the usual manner, is to be placed in a clear charcoal fire to burn off the cotton and oil, when the whole remaining tissue will be pure white amianthus. The shorter fibers that are incapable of being woven, have been sometimes made into paper, the process for which is the same as that employed for common paper, except that a greater proportion of paste or size is required. After having been made red hot, however, this paper becomes bibulous and brittle. Amianthus threads are also sometimes used as perpetual wicks for lamps; they require, however, to be cleaned occasionally from the soot that collects about them, and the fibers in the hottest part of the flame are apt to run together, so as to prevent the due supply of oil. In Corsica, amianthus is advantageously employed in the manufacture of pottery; being reduced to fine filaments, it is kneaded up with the clay, and the vessels which are made of this mixture are lighter, less brittle, and more capable of bearing sudden alterations of heat and cold than common pottery. Many patents have been taken out in recent years for various applications of this substance, some of the most important of which are as follows: lining for safes; lamp wicks; fire brick and crucibles; packing for engines of various kinds; boiler covering; for porcelain manufacture, of teeth especially, placed on the side of the muffle to isolate the biscuit from the slide and prevent its becoming attached thereto in the process of baking; as an anti friction composition for journals, etc.; for moulded articles; for roofing and flooring cement; for refrigerators; ink; paper; coffins; ropes, and yarn for weaving.

2. *Common Asbestos.*—The color of this mineral is leek or mountain or olive green; greenish or yellowish gray or grayish white. It is found amorphous, or investing other substances; the form of its filaments appears to be that of a very long rhomboidal prism; it is shining or glimmering, with somewhat of a greasy luster; its fracture is fibrous and much more compact than that of amianthus, passing into the broad striated. It flies, when broken, into long splintery fragments; it is translucid at the edges and may be scratched by the nail with some difficulty. Specific gravity 2·5 to 2·8. Wiegleb gives the component parts of common asbestos as 48·45 magnesia, 46·66 silex, and 4·79 oxide of iron. This mineral is of more frequent occurrence than amianthus, being found almost universally accompanying serpentine, and very often mixed with magnetic iron ore. It passes by insensible gradations into the preceding species.

3. *Ligniform Asbestos.*—The color of this mineral is yellow or Isabella brown. It is found massive and is internally glimmering. Its fracture is thin and finely foliated; it is opaque, may be scratched by the nail, adheres to the tongue, and has a meager feel. Its specific gravity is 2·051. It is infusible *per se* before the blowpipe. It is met with principally in the Schneeberg of Tyrol in the same gangue with galena, blende, common asbestos, strahlstein, and gypsum.

4. *Mountain Cork or Mountain Leather.*—The color of this mineral is yellowish or reddish white, yellowish green, or ocher yellow. It is found amorphous in thick or thin plates; it is weakly glimmering internally. It has a thick, uneven, somewhat foliated fracture; is opaque, somewhat elastic, and floats upon water. The specific gravity is 0·68 to 0·99. Bergman gives the following analysis of its composition: 26·10 magnesia, 56·2 silex, 2 alumina, 12·7 lime, and 3 oxide of iron.—*Pottery and Glassware Rep.*

LIQUEFACTION OF OZONE.

Le Génie Civil gives an account of a successful attempt at the liquefaction of ozone which was recently made by Messrs. Hautefeuille and Chappuis. It is only recently that oxygen has been liquefied, and hitherto its strange allotropic form has resisted all efforts to change it from its gaseous condition. By subjecting a mixture of ozone and oxygen to a pressure of one hundred and twenty-five atmospheres, or nineteen hundred pounds to the square inch, cooling it at the same time by immersion in a jet of liquefied ethylene to a temperature of at least one hundred and fifty degrees below zero of Fahrenheit's scale, these experimenters succeeded in reducing it to a liquid of a very deep indigo-blue color, which, although obtained under such enormous tension, proved to have a certain amount of stability, and evaporated only slowly when the pressure was reduced one-half. Even under the ordinary pressure of the air some drops of the blackish liquid lingered for a few moments before they were again transformed into an azure vapor, which on returning to its ordinary condition proved to have undergone no chemical change.

FORMULAS FOR PROPRIETARY MEDICINES.

THE following formulas are taken from the *American Drug Mill*:

Coe's Dyspepsia Cure.

NELSON.

Powdered rhubarb	2 drachms.
Fluid extract of gentian	3 "
Peppermint water	7½ ounces.
Bicarbonate of soda	6 drachms.

Mix them. Dose, a teaspoonful half an hour before meals.

Piso's Consumption Cure.

NELSON.

Sirup of morphia (1 grain to ounce)	4 ounces.
Chloroform	2 fluid drms.
Glycerin	3¼ "
Hydrocyanic acid—dilute	1 drachm.
Chlorophyl q. s. to tint.	

Mix the chloroform with the glycerin. Add the other ingredients and mix. Adult dose, a teaspoonful.

Dr. Pierce's Golden Medical Discovery.

NELSON.

Fluid extract of cinchona	16 ounces.
Fluid extract of calumba	4 "
Fluid extract of guaiacum	8 "
Fluid extract of licorice	4 "
Tincture of opium	1 ounce.
Podophyllin (*resinoid*)	120 grains.
Glycerin	6 fluid pts.

Alcohol a sufficient quantity. Dissolve the podophyllin in the alcohol and add the rest of the ingredients. Mix them. Dose, a teaspoonful.

Dr. Pierce's Favorite Prescription.

HAGER.

Savin	10 grammes.
Agaric	5 "
Cinnamon	5 "
Peruvian bark	10 "
Make a decoction of	220 "
And add gum arabic	10 "
Sugar	5 "
Tincture of digitalis	2 "
Tincture of opium	2 "
Oil of anise	8 drops.
Solve in alcohol	45 grammes.

Walker's Vinegar Bitters.

Powdered golden seal	1 ounce.
Powdered aloes (*Cape*)	¼ "
Water	16 ounces.

Bottle up, tie the cork down tightly. Ready for use in ten days.

Mrs. Winslow's Soothing Sirup.

NELSON.

Sirup of morphia	8 ounces.
Essence of anise	½ ounce.
Sirup of balsam tolu	7½ ounces.

Mix them.

Ayer's Cherry Pectoral.

Sirup of wild cherry	6 drachms.
Sirup of squills	3 "
Tincture of bloodroot	2 "
Sweet spirits of niter	2 "
Wine of antimony	3 "
Wine of ipecac	3 "
Sirup	1½ ounce.
Acetate of morphia	2 grains.
Spirit of bitter almonds	1 drachm.

Mix.

Ayer's Sarsaparilla.

Fluid extract of sarsaparilla	3 ounces.
Fluid extract stillingia	3 "
Fluid extract yellow dock	2 "
Fluid extract podophyllin	2 "
Sugar	1 ounce.
Iodide of potassium	90 grains.
Iodide of iron	10 "

Mix them.

Hamlin's Wizard Oil.

J. J. PIERSON, PH.C.

Spirit of camphor	1 ounce.
Spirit of ammonia	½ "
Oil of sassafras	½ "
Oil of cloves	2 drachms.
Chloroform	½ ounce.
Oil turpentine	½ "
Alcohol q.s. to make	5 ounces.

Mix them.

Radway's Ready Relief.

J. J. PIERSON, PH.C.

Soap liniment about	1½ ounces.
Tincture of capsicum, about	½ ounce
Aqua, ammonia, about	½ "
Alcohol	½ "

Mix them.

Flagg's Relief.

J. J. PIERSON, PH.C.

Oil cloves, about	1 drachm.
Oil sassafras, about	2 "
Spirit of camphor, about	1½ "

Mix.

Perry Davis's Pain Killer.

J. J. PIERSON, PH.C.

Spirit of camphor, about	2 ounces.
Tincture of camphor, about	1 ounce.
Tincture of guaiacum, about	1½ "
Tincture of myrrh, about	½ "
Alcohol—color—about	3 "

Mix them.

Canada Liniment.

Aqua ammonia	1 ounce.
Olive oil	1 "
Oil of turpentine	1 "
Alcohol	1 "
Oil of peppermint	½ "

Mix them.

Chamberlain's Relief.

J. J. PIERSON, PH.C.

Tincture of capsicum, about	1 ounce.
Spirit of camphor, about	¾ "
Tincture of guaiacum, about	¼ "
Color tincture, to make	2 ounces.

Mix them.

Kellog's Red Drops.

Spirit of camphor	2 ounces.
Spirit of origanum	½ ounce.
Oil sassafras	¼ "
Oil turpentine	½ "
Color tincture, about	4 ounces.

Mix them.

Tobias's Venetian Liniment.

HAGER.

Spirit of hartshorn	5 parts.
Gum camphor	5 "
Tincture of capsicum,	
Alcohol	30 "
Water	10 "

Mix them.

Piels's Fit Powders.

Bromide of potassium	15 grains.
Powdered gentian	5 "

Mix—make one powder.

Hall's Hair Renewer.

Lac sulphur	1 drachm.
Sugar of lead	1 "
Salt (common)	2 "
Glycerin	8 fl. ounces.
Bay rum	2 "
Jamaica rum	4 "
Water	16 "

Mix. Shake before using.

Holloway's Pills.

Powdered aloes	36 grains.
" jalap	18 "
" ginger	18 "
" myrrh	18 "

Sage's Catarrh Remedy.

HAGER.

Powdered golden seal	5 parts.
Indigo	½ "
Powdered gum camphor	2 "
Carbolic acid	2 "
Salt (common)	50 "

Injection Brou.

HAGER.

Distilled water	100 parts.
Sulphate of zinc	0·50 "
Sugar of lead	200 "
Tincture of catechu	200 "
Sydenham's laudanum	200 "

Mix them.

Red Horse Condition Powders.

Powdered fœnugreek	2 ounces.
" gentian	2 "
" black antimony	2 "
" capsicum	2 "
" cream of tartar	2 "
" rosin	2 "
" saltpeter	2 "
" myrrh	1 ounce.
" ginger	1 "

Mix them.

Tobias's Derby Condition Powders.

HAGER.

Powdered tartar emetic	2 grammes.
Crude antimony	20 "
Sulphur	10 "
Saltpeter	10 "
Powdered fœnugreek	40 "
Good juniper berries	20 "

Mix them.

Thompson's Eye Water.

Sulphate of copper	10 grains.
Sulphate of zinc	40 "
Rose water	2 pints.
Tincture of saffron	4 drachms.
Tincture of camphor	4 "

Mix and filter.

PRACTICAL NOTES.

By R. F. FAIRTHORNE, PH.G.

Extract of Vanilla.—So many formulas have been published by which this extract or tincture can be made, that it seems almost superfluous to offer another, yet, having tried many of them, I found none so satisfactory as the following:

℞. Vanilla bean, of good quality	1 ounce.
Rock candy	2 ounces.
Alcohol	9 fluid ounces.
Water	7 "

Cut the vanilla as small as possible with a sharp knife, then transfer it to an iron mortar, and beat it and the rock candy into powder, which is to be put into a bottle with the alcohol and allowed to macerate therein, with occasional agitation, for twenty-four hours. Then add the water, treat in the same manner for two days, and filter the extract, which will be found to possess a strong flavor and good color.

Extract of Herbs for Flavoring Soups, etc.—The addition of herbs to soup so as to flavor it pleasantly has suggested the advisability of making a preparation that will contain and retain unchanged the various flavors usually employed. The delicate aroma of many of them is impaired by time and exposure, and it is therefore desirable to preserve them, which is done when made into an extract in the following manner:

℞. Savory, sweet marjoram and basil	each 2 ounces (troy).
Sage,	
Black pepper	each ½ ounce, "
Thyme	½ " "
Celery seed	1½ drachm.
Alcohol	3½ pints.
Water	½ pint.

Reduce the dry ingredients to a coarse powder. Pack them tightly in a percolator, after having moistened them with six fluid ounces of the mixture of alcohol and water. Pour on the remainder of the menstruum. As soon as the liquid ceases to pass through, displace with diluted alcohol sufficient to make the product measure four pints. This will be found a very palatable addition to soups and gravies.

As delicate persons frequently complain of the insipidity of beef tea, or infusions of extracts of meat, I have found that their objections can be overcome by mixing four or five drops of the "extract of herbs" with each wineglassful of the tea, so that they can take it with relish. For this reason I think it is a desideratum for the druggist to be able to offer to such customers a preparation like that described above. Some invalids, however, prefer the flavor of celery, which can be made by the following formula and the same quantity used as of the former:

℞. Celery seeds (bruised)	6 drachms.
Alcohol	14 fluid ounces.
Water	2 "

Macerate for two days and filter.

Marking Pill Cutting Machines.—One of those small contrivances that add to the convenience of the dispenser of prescriptions consists of marking each groove of the pill machine consecutively, thereby saving the time required to count them, which is often quite desirable, especially when the pills are wanted in a very short time. It is most convenient to begin marking the numbers from left to right. This can be readily done by using a fine pen and indelible ink, which will remain permanent and stand any amount of washing. A good plan is to mark each groove at the top, except every fifth one, which is best to have the number placed at the bottom, in order to make the numeration more easily read. This will be found especially desirable for the pill machines that cut small pills, such as one grain, so that the fifth, tenth, fifteenth, twentieth, and twenty-fifth grooves can be distinguished at a glance. The ink should be made with nitrate of silver.

Antiseptic Cologne.—

℞. Cologne	8 fl. oz.
Chloral hydrate	2 dr.
Quinine (alkaloid)	10 gr.
Carbolic acid (pure)	30 gr.
Oil of lavender	20 drops.

Having frequently noticed that when carbolic acid is mixed with chloral, the odor of the former is either covered or removed, I prepared the cologne as above, and found that it was by no means disagreeable. It can be used in the form of spray or on the handkerchief, and, as it contains three well known antiseptics, it may possess some valuable properties. It was made up, however, several years ago, to supply a popular demand for such an article, and gave satisfaction, at least to some who used it; but whether from increasing the confidence of those using it, in the belief of its prophylactic effects, or from its really possessing such, I am not able to state, but must leave it for others to determine.

Solution of Citrate of Magnesium.—An improvement can be made in making this solution by using calcined magnesia instead of the carbonate. This is due to the fact that when light calcined magnesia is employed, the citrate is free from a peculiar flavor that is scarcely capable of description, except by the term earthy. In the following receipt the same amount of citric acid is employed as called for by the formula given in the United States Pharmacopœia, and yet if any druggist will take the trouble to make it by this receipt, he will find a marked difference in the taste of the solution. He will also find that a beautifully clear preparation is obtained.

℞. Light calcined magnesia	7 dr. 55 gr.
Citric acid	4 troy oz. 1 dr. 45 gr.
Bicarbonate of sodium	1 dr. 40 gr.
White sugar	6 troy oz.
Oil of lemon	3 drops.
Bicarbonate of potassium	q. s.

Water sufficient to make 50 fluid ounces.

Dissolve the citric acid in 20 fluid ounces of hot water; add the magnesia, and when solution is effected add the sugar, then the bicarbonate of sodium, the oil of lemon, and cold water. Filter, and of this put 10 fluid ounces in a suitable bottle, with 40 grains of bicarbonate of potassium. Cork tightly and tie over as usual.—*American Journal of Pharmacy.*

PATCHOULI.

PATCHOULI, or putcha-pat, is the Hindostanee name of the plant from which the perfume is obtained, which is known to botanists as *Pogastemon patchouli*. It belongs to the order *Labiatæ*, which furnishes us with so many of our aromatic plants, such as sage, thyme, marjoram, rosemary, lavender, mint, pennyroyal, etc.

The patchouli is tall and shrubby, not unlike the garden mint in habit, with broad, egg-shaped, opposite leaves, about three inches long, and thick spikes of small purplish-white flowers. It is a native of Penang, Silhet, and the Malay Peninsula, and is imported into England from Hindostan and Bengal. In India it is a very popular perfume, besides being used in tobacco for smoking and for scenting the hair of women.

When it was first imported into England, in 1844, a few cases were put up for sale at Garraway's coffee house; the price asked was only six shillings per pound, but there was no bidding. The plant flowered in Europe for the first time in the winter of 1844, in the greenhouse of a gentleman at Orleans; since then it has been in cultivation in many botanical gardens, and may usually be seen in the Economic House at Kew. The odor of patchouli may be detected in India ink, in the manufacture of which it is an ingredient. The dried leaves and the tops are the parts imported. The patchouli plant is in great favor with the Arabs, who use and export it more than any other nation. They use it largely in stuffing mattresses and pillows. They believe it to be very efficacious in preventing contagion and prolonging life. The perfume is said to have a very powerful effect upon some people, producing loss of appetite and sleep. The scent is more powerful in dry than in damp places. The odor is due to the volatile oil which is contained in the leaves and stems. When distilled it is of a yellowish green color, with the same smell as the herb, but has neither a burning nor an astringent taste. It is almost as heavy as water. A hundredweight of the plant yields about twenty-eight ounces of oil.

OLEARIA GUNNIANA.

UNDER the name Eurybia Gunniana this beautiful flowering composite shrub has been long known in gardens, but as Eurybia can not be generically separated from Olearia the older name must give place to that here adopted. Olearia Gunniana, a fine specimen of which was shown recently by Messrs. Veitch, is a Tasmanian shrub of 3–5 feet in height, with hoary branches and polymorphous leaves. In the form before us they are oblanceolate, coarsely toothed, and hoary on the under surface. The starry flower-heads are very numerous, clothing the ends of the branches with a sheet of white. Each flower head is about the size of a shilling, with spreading white rays and a grayish disk. In sheltered situations it would survive our winters, as we believe it does at the Combe Wood Nurseries, near Kingston-on-Thames, and its beauty is such that it may be safely recommended for cultivation in any suitable locality. Even in less favored spots a very slight amount of protection would probably suffice to preserve the plant. In any case it would make a fine conservatory shrub, though we doubt if the blooms would be as handsome as they are out-of-doors. Olearia Gunniana was described as a Eurybia by De Candolle in the "Prodromus," vol. v., and afterward by Sir Joseph Hooker in the sixth volume of the "London Journal of Botany," as well as in the same author's "Flora of Tasmania," vol. i., where a colored illustration of the plant is given.—*The Gardeners' Chronicle.*

OLEARIA GUNNIANA

HINTS AND SUGGESTIONS FOR RAISING CINCHONA PLANTS.

IN order to promote the spread of cinchona cultivation in the Island of Jamaica, the following information has been published under government auspices :

I.—RAISING SEEDLINGS IN BOXES.

Boxes.—For raising small quantities of plants—say from 20 to 80,000—it is desirable to sow the seed in small shallow boxes under cover, where they can be conveniently attended to.

The boxes may be of any size as regards length and breadth, but should not be more than about three or four inches deep. Ordinary brandy or wine cases reduced to the above depth answer well.

To promote drainage, holes about three-quarters of an inch in diameter should be made in the bottom of the boxes at distances of about six inches apart. The inside of the boxes should be treated with whitewash, or thoroughly dusted with quicklime, to prevent mouldiness of the soil and subsequent injury to the young seedlings. Over the holes in the bottom of the boxes place pieces of broken pots or brick, and cover the surface to the depth of one inch with rubble or broken stones.

Soil.—The soil for the boxes should consist of one third of leaf mould, or that kind of soil of a black peaty character which is often to be found under large trees in the forest; one-third of good ordinary garden soil, and one-third of sharp sand or fine river gravel. These should be mixed thoroughly together and passed through a quarter inch sieve.

The boxes may then be filled within one-quarter inch of the top, with the sifted soil placed over the broken stones, etc., and slightly pressed so as to present an even unbroken surface.

Sowing the Seed.—After slightly watering the soil in the boxes, the cinchona seed, which is very light and small, should be sprinkled rather thickly over the surface, so as to cover nearly every part of the rich brown tint. When this has been done, take a small quantity of the fine sifted soil, mentioned above, and sprinkle it over the seeds, *barely covering them.*

Watering and Shading.—The boxes should then be placed in the shade sheltered from sun, wind, and rain, and kept regularly watered, daily, with the finest possible spray, from a watering can. Under the conditions above mentioned, the seeds will begin to germinate in about three or four weeks. They will require regular watering, however, till they are one and a half or two inches high, when they are ready for the nurseries.

II.—RAISING SEEDLINGS IN BEDS.

Where seedlings are required to be raised on a large scale it is advisable to grow them in beds protected by a roof of shingles or good thatch. The roof, sloping south, and supported on posts four feet six inches high on the north and three feet three inches on the south side, should completely cover the beds and keep off both sun and rain. It is also advisable to shelter the sides of the sheds by grass or wattle fence, so as to keep off the slanting rays of the sun and strong winds.

The beds should run in parallel rows due east and west; be about three feet wide and with a path between each bed about two and a half feet wide. After the beds are laid out, the surface should be covered to the depth of two or three inches with the same mixture of soil as recommended above for the boxes. The beds may then be sown and kept regularly watered night and morning.

III.—ESTABLISHING CINCHONA NURSERIES.

Nursery Beds.—When seedlings have been raised either in boxes or beds, and are about one and a half or two inches high, the next step is to transplant them into the nurseries. In selecting situations for seed beds and nurseries, it should be borne in mind that a sheltered situation and a plentiful supply of water are no less important considerations than nearness to the land intended to be planted.

The beds for the nurseries should be laid out in every respect as for seed beds, *i. e.*, about three feet wide, with paths two and a half feet wide, treated on the surface with a mixture of good soil, and placed in rows due east and west.

Before the seedlings are transferred to these beds it would be well to prepare beforehand the necessary materials for shading them.

These may consist of long straight wattles, supported on forked sticks covered with grass, ferns, or palm leaves. Side shading is also advisable, especially on the south side.

Pricking out seedlings into nurseries is a work requiring great care; but with a little experience it can be done very successfully and expeditiously.*

The seedlings being about one and a half or two inches high may be carried in the boxes or raised from the seed beds in lots of 200 or 300 and brought into the nursery. The beds already prepared for them should receive a good watering and be pressed evenly by gentle tapping with a piece of board. The person about to prick out should be provided with a small wooden peg about four or five inches long and three-quarters of an inch in diameter at one end, tapering to a dull rounded point at the other. Taking up a seedling carefully by the leaves, with the left hand, a small hole should be made with the peg in the right hand, just deep enough to take the tender roots of the seedling without bending or crushing them. When placed in the hole, the soil should be pressed closely to the rootlets by means of the peg, and the seedling left firmly fixed with its leaves and stem well above ground. The seedlings should be placed in rows at regular distances apart so as to allow about two inches between each plant.

As soon as an appreciable number of seedlings have been pricked out, the shading, as shown above, should be immediately placed over them to prevent injury from sun or rain.

The nursery beds will require regular watering for some time, but when the plants are about four or five inches high it would be well to remove the shading, little by little, in order that the plants may become gradually hardened and ultimately fit for transplanting to their permanent places in the field.

IV.—ESTABLISHING CINCHONA PLANTATIONS.

Climate.—It may be generally accepted for Jamaica (between 17° and 19° latitude north, and 75° and 79° longitude west) that, at all elevations from about 2,500 feet to the Blue Mountain Peak, 7,335 feet, the climatic conditions are all favorable for the successful cultivation of one or other of the various species of cinchona. For comparison, it may be mentioned that *Cinchona succirubra* flourishes in the parish of Manchester, according to information supplied by Mr. Swaby, at an elevation of 2,700 feet, with a rainfall of about 120 inches, and a mean annual temperature of 70° Fahrenheit. This elevation may be taken as nearly the lowest at which the more valuable cinchonas may be remuneratively grown in Jamaica.

At the government cinchona plantations *Cinchona succirubra* flourishes at 5,000 feet. The records here show a mean annual rainfall of 136 inches and a mean annual temperature of 60° Fahrenheit. The trees at this elevation do not seed freely, and are apparently so slow in maturing that this elevation may be taken as the highest at which it would be advisable to cultivate red bark in Jamaica.

For the valuable crown bark, *Cinchona officinalis*, as it flourishes at 4,500 feet near Whitfield Hall, and at 4,800 feet at the cinchona plantation, possibly it may grow as low as 4,000 feet. Its range of cultivation, so far, in Jamaica is between 4,500 and 6,300 feet; a few plants of this species planted by Mr. Nock, on Blue Mountain Peak, in 1878, though they have suffered from their exposed position, would indicate that the conditions, even at this elevation, are not unfavorable to the growth of small leaved and hardy cinchonas.

Soil.—All species of cinchonas are most impatient of stagnant moisture at their roots, and therefore require an open sub-soil, a sloping exposure, and other conditions of perfect drainage. They naturally prefer a rich soil, and do better in newly cleared forest than in grass lands. *Cinchona officinalis* is, however, more tolerant than *C. succirubra* of a soil poor in vegetable humus, and grows on grass land, as well as on exhausted coffee soils.

The freer and more friable the surface soil the better, but the ultimate success of the cinchona plant depends essentially on the character of the sub-soil. An open, well drained sub-soil is above all things indispensable to cinchona cultivation.

"As soon as the roots of a cinchona tree get down into sub-soil, in which there is any tendency for moisture to collect, the plant most certainly begins to sicken and die."

The best trees at the government cinchona plantations grow in a good friable surface soil, overlying a porous stony sub-soil produced by decomposed rock of the metamorphosed series of Jamaica geology. This sub-soil is found generally distributed throughout the parishes of St. Andrew, St. Thomas, and Portland. In limestone districts of the island eastward the soil generally must be very favorable to cinchona cultivation, the only qualifying conditions being the elevation and mean annual rainfall.

Sites for Plantations.—In selecting sites for cinchona plantations, it is important to bear in mind the points above mentioned, as regards climate and soil, and the species of cinchona naturally adapted for them.

Where cinchona is cultivated concurrently with coffee, it is recommended to attempt to grow the valuable crown bark, *C. officinalis*, at all elevations above 4,000 feet, on rather bare patches, by road sides and indeed anywhere where plants can be placed, this hardy and valuable plant should be abundantly grown.

On coffee plantations below 4,000 feet the most suitable kinds are the red bark, *C. succirubra*, and a hybrid variety which has passed here as *C. calisaya*. These may be planted on coffee estates, as suggested above for *C. officinalis*.

In selecting sites for permanent cinchona plantations as distinct from coffee plantations, the nature of the soil, the direction of prevailing winds, the aspect, mean annual temperature, and annual rainfall, are all matters for serious consideration. Speaking generally, however, no sheltered situation with good soil can be said to be unsuitable for cinchona anywhere on the Blue Mountain range. The northern aspect has a more equable temperature than the southern, but the latter appears to be generally preferred for coffee. As cinchonas delight in a moist equable temperature it is very probable that vast tracts of land lying hitherto uncultivated on the northern slopes of the Blue Mountain range will ultimately prove suitable for cinchona.

Clearing Land.—When it is intended to establish a cinchona plantation on uncleared land, the first consideration, after the site has been carefully selected, is to establish the seed beds and nurseries. Full particulars respecting these are given in the foregoing paragraphs. While the plants are being thus prepared the land intended for the plantation should be properly cleared as for coffee cultivations.

It may be well, however, to point out that it is very advisable in Jamaica to leave moderately wide belts of forest standing on the ridges, for the purpose of affording shelter from strong winds. In addition to this it is recommended, on very steep places, rocky hollows, and any patches of land unsuitable for cinchona, that the original forest be left standing in order to insure adequate shelter for the cinchonas as well as save needless expense of cutting down, weeding, etc.

In India the methods pursued for clearing forest for cinchona cultivation are described as follows: "The best time for beginning to clear forest land for cinchonas is obviously when the dry season has sufficiently advanced to make a second growth of grass improbable. When the felled forest, whether grass or timber, is sufficiently dry it may be fired. Stumps and logs remaining unburnt after the fire may be rolled into spots unsuitable for planting, or heaped together and burned. A better way is to lay them between the lines of plants, and allow them to rot and thus to profit by the humus formed by their decay. The large fibrous roots of tall grasses and other weeds likely to overpower the young trees about to be planted should be dug out and killed either by exposure or burning. The land being thus cleared, any necessary roads may be lined off and made. The sites

* At the cinchona plantation, pricking out seedlings is done by contract at the rate of 9d. per thousand. A man or woman after a little experience can prick out about 2,000 per diem.

in which the plants are to be put must then be marked off. This may be conveniently done by means of a cord, about 100 feet long, on which marks are tied at the intervals at which it is wished to plant the trees. This cord is stretched on the ground, and opposite each of the marks on it a piece of split bamboo or a peg is stuck in the soil. The cord is then moved, another line is staked off at a proper distance from the last, and so on. Coolies follow, whose duty it is to dig pits, about a foot to fifteen inches in depth, and eighteen inches wide, of which the stakes already put in should be the centers. The earth (freed from roots and stones) which has been taken out of each hole *should be returned to it*, so as to form a free mass in which the roots of the plant about to be planted can freely work. A cooly in Sikkim makes one hundred to one hundred and thirty of such pits per day according to the nature of the ground."

Planting.—When the ground has been prepared, as mentioned above, the plants already established in the nurseries, after being gradually hardened, will be fit for planting out. The night before the plants are taken out of the nursery beds they should be well deluged with water, in order that a good ball of soil may adhere to their roots in the process of transplanting. The plants should be carried from the nurseries to the fields in shallow boxes or baskets, well shaded from the sun, and with a plentiful supply of wet moss, grass, or ferns, round the roots. The best season for planting in Jamaica is evidently after the October rains, and the most favorable conditions are obtained during a prevalence of damp, cloudy, or foggy weather, with only slight rain or occasional showers. It is unadvisable to plant during heavy rains as, most soils get clogged and heavy, and become in this state prejudicial to the tender rootlets of the plants. In placing the plants in the holes it is only necessary to make an opening with the hand or a trowel in the fresh loose soil already prepared for them, sufficiently deep to receive the roots without doubling them. When thus deposited the soil should be filled in round the plant and well pressed as it is thrown in to cover the roots. No plant should be buried deeper in the ground than the collar or union of stem and roots. "When a portion of the stem is buried in transplanting, the growth of the plant is much retarded, and it does not, as some suppose, give a firmer hold of the ground, but the reverse."

Too much attention cannot be given to the modes of putting out cinchona plants. "It is too important an operation to be done badly; it is not wise to try to economize on it, and it is always unadvisable to do it by contract." A good planter should be able to put in from five hundred to a thousand plants per day, according to the nature of the soil.

Planting Distances.—In the early days of cinchona planting the trees were put out at distances of twelve feet apart, but it was soon found out that even for the strong and free growing red bark, *C. succirubra*, this distance was too great for remunerative results. "It appears that the red bark, even in South America, is never a large tree: *C. officinalis* is but a big shrub, and it is doubtful whether any of the species become much larger."

In the government plantations of India, at Sikkim, the Nilgiris, and Dargeeling, even the large-leaved *Cinchona succirubra* are now planted at distances of four feet by four feet, giving two thousand seven hundred and twenty-two trees per acre, whereas when planted at twelve feet by twelve feet, as hitherto followed in Jamaica, the number of trees is only three hundred and three trees per acre. Dr. King, in his "Manual of Cinchona Cultivation in India," remarks that "wide planting is obviously an error." All the cinchonas have the habit of throwing out a quantity of superficial rootlets, and young cinchona plantations do not thrive until the soil between the trees is sufficiently protected from the sun to allow these superficial rootlets to perform their functions freely. The growth of weeds, which is a very important factor in tropical cultivation, is also checked by shade. By close planting, therefore, two desirable objects are speedily obtained, and, moreover, the trees are encouraged to produce straight clear stems yielding a larger proportion of trunk bark and less branch bark. On this well-known habit of forest trees is founded the practice of close planting in forest plantations in Europe, the object being to produce long straight unbranching stems from which to cut timber of long scantling.

As the trees begin to press upon each other, they can be thinned out, and a quantity of bark may thus be got at a comparatively early period, with positive advantage to the plants that are allowed to remain on the ground. It is true that the cost of close planting is greater than that of sparse planting, but on the other hand the reduction in the cost of cleaning and the manifest greater yield of the plantation will more than compensate for this.

It may, therefore, be safely assumed that the red bark, *C. succirubra*, should be planted at distances not greater that four feet by four feet, and the crown bark, *C. officinalis*, at not greater than three feet by three feet.

The latter may, however, very conveniently be put out at distances of three feet between the rows and only two feet between each plant.

Shading.—It is very advisable to give the newly planted plants some shade for a short time after they are put out. The best and cheapest mode for any particular locality must of course depend on local conditions. At the government cinchona plantations it is found very convenient to place two or three sprays of the common bracken, *Pteris aquilina*, on the sunny side of the plant, with the stalks well fixed in the ground. Should the weather prove wet, with high gales of wind, the fern leaves should be slightly moved on one side, so as not to touch or rub the plant when moved by the action of the wind.

Staking.—In windy localities it is often necessary when plants have attained the height of two or three feet to give them support by stakes. The great danger to be avoided in staking the plants is the chafing caused by the swaying of the plant. If the material used for tying is of a soft nature and the stakes are placed in a sloping direction so as only to touch the plants at one point much of the evils of chafing may be avoided.

Weeding.—Sooner or later a newly planted clearing will begin to show signs of the numerous tropical weeds which everywhere infest the land. It is hopeless to think of ever entirely freeing the ground from such unwelcome visitors, and, indeed, in the case of a cinchona plantation it is quite unnecessary to do so. No special rule can be laid down as to the number of cleanings actually required during the first and second years, but it would be advisable to keep down by cutting most weeds till the young plants are sufficiently grown to overtop them. Hoe-weeding, as a *general* treatment, should never be permitted, as thereby the valuable surface soil is loosened and washed away.

"Where the majority of the weeds are annuals, and the soil is soft and friable, it may be advisable occasionally to substitute hand-weeding for cutting.

"The disturbance of the surface of the soil caused in pulling the weeds up by the roots affords a rough kind of cultivation which is advantageous; moreover the superficial roots of the cinchonas are less damaged than by hoeing. It need scarcely be stated that in proportion as the cinchona trees grow and their leafy heads cover the ground the undergrowth of weeds becomes less luxuriant. A slight superficial hoeing of the soil immediately round the plants should, however, be given once a year if possible. The space to be cleared need not exceed one and a half to two feet in diameter, having the tree stem as its center. To young plants especially this is very beneficial, and it is found that the oldest trees in the Sikkim plantation are much benefited by the operation.

"In all cultural operations it ought to be borne in mind that the roots of cinchonas are comparatively superficial, and that any very deep hoeing is therefore more likely to do harm than good."

A NEW STUDY OF GLACIERS AND ICEBERGS.

DANISH EXPLORATION OF THE JAKOBSHAVN GLACIER, GREENLAND.

AN expedition sent out to Greenland by the Danish Government in the fall of 1879 to explore the great Jakobshavn glacier has recently made an interesting report to the Royal Commission for the exploration of Greenland. Its chief purpose, to determine the speed of the great glacier's progress toward the sea in the winter months, was accomplished under exceptionally discouraging circumstances by R. Hammer, a lieutenant in the navy, who commanded the expedition. Previous investigations by Rink in 1850, and by Helland in 1875, had shown that the Jakobshavn glacier in the summer moved seaward at the rate of fully sixty feet in twenty-four hours, while the Swiss glaciers travel only a few inches in that time. The discovery that in the depth of the Arctic winter its speed fell very little short of this was, however, an unexpected conclusion; the measurements made by Mr. Hammer, nevertheless, fully prove this.

The Jakobshavn ice-fjord (69° 12' north latitude) was chosen as the point of observation, because the glacier through which it reaches the sea from the unexplored interior is the greatest, and sends forth the largest number of the icebergs that crowd the Polar Sea. The belt of coast land that is not covered with perpetual ice is at Jakobshavn about twenty miles wide. Beyond it the inland ice covers hills and valleys, and feeds the huge glacier which packs the inner fjord at all seasons. The mouth of the fjord in Disco Bay is closed by a bar of mud, upon which the larger icebergs ground as they break off at the end of the glacier, choking up the fjord and preventing all communication between Jakobshavn and Claushavn, at the south side of the fjord, except by boat outside the bar. When large icebergs from time to time slip over this bar, an opening is made through which quantities of ice push out into the bay, to the great danger of any boats that happen to be there, as the occurrence is always sudden and unforeseen. But when the glacier "kalver"—*i. e.*, when the outer end breaks off, and forms icebergs that turn over and over in the effort to attain their balance—the disturbance of the waters extends far out into the bay, and at times may be traced many miles down the coast. Ice three or four feet thick is broken miles away like fragile glass. The Danes in Greenland understand well the cause of this commotion, though the actual process of the "kanel" has only been observed by a European once; but the natives believe that it is the work of the spirits of the glacier, whose fastnesses are far in the unknown interior of the country. During the winter of 1879 this phenomenon occurred thrice.

Hammer started for the glacier from Claushavn in September, expecting to make his base of observation in the little inlet Kongerdlukasik, which in 1875 had been passed and entirely shut off by the glacier on its seaward march. He reached it after great hardships, only to find that the glacier had receded up the fjord so far that it could not even be seen from that point. The mountain sides of the inlet were too steep to climb, and in an attempt to do so the explorers were surprised by a terrible snowstorm, and had to spend the night in a ravine in imminent danger of being frozen to death. After ascertaining that the glacier, since 1850, had moved back fully four miles, they were compelled to return to Jakobshavn to spend the long Arctic night. It was only on January 13 that half of the sun's disk appeared above the horizon again, and travel in dog sleds became possible. Several attempts were made to reach Kongerdlukasik, and the trip to Umenak, a distance of 160 miles, over mountain ranges 2,000 feet high, was made in a sled with one team of eight dogs in three days and a half with the thermometer at —40° C., but the object was not attained till the middle of March. The glacier had pushed ahead and was again visible from the inlet, but this was so closely packed with ice, screwed up in all sorts of shapes, that twenty-four hours' hard work only brought the party 400 feet nearer the ice-fjord, and another way had to be found. It was noted by measurements, as accurate as the distance would permit, that in that night the end of the glacier advanced perceptibly, though the thermometer showed —30° C. On March 21 the main ice-fjord was at last reached, and from that day until the end of April numerous measurements were made from both ends of a fixed base to ascertain the speed with which the glacier was moving. As to get upon the moving mass was impossible, the tall peaks and blocks of ice that projected from its uneven surface were used as landmarks; quite frequently these would suddenly tumble down and disappear, and the work would go for naught.

MOVEMENTS OF A GLACIER.

The glacier at this point was three miles wide, and its end was a perpendicular wall 200 feet above the ice surface of the fjord. The roughness of its surface was greatest nearer the sides; toward the middle it disappeared entirely. Although the observations were made at a time when the winter's frost was most severe, and had lasted long enough to penetrate as far into the glacier as its effect might be felt, the whole mass was found to be moving steadily ahead. Its velocity increased greatly from the edges of the glacier toward its middle. On account of the lack of projecting points near the middle, the speed of that portion could not be as accurately measured as that of the flank sections, but was estimated to reach at least fifty feet in twenty-four hours. The average speed of a point in the glacier, 1,790 feet from the edge of the fjord, was 39·8 feet in twenty-four hours. Constant detonations, sometimes like the firing of heavy guns, but more frequently like pistol shots, accompanied the movement of the glacier. It was faster on some days than on others, and apparently without regard to time of day or night, or to the temperature of the atmosphere. From the top of the adjacent hills two lines could be observed running lengthwise on the glacier, dividing it into three nearly equal parts; they marked the lines of friction where the central part moved independently of the flanks. The natural conclusion was that the latter drag on the shore and on the rocky bottom, and that the resistance they meet with makes them move more slowly, and causes the roughness on their top, while the central part of the glacier, floating on water, preserves its even surface and moves along faster. The fact that the middle of the glacier seemed to lie higher than the rest supported this theory. Floating free, the end of the glacier is buoyed up at last by the tidewater until it breaks off in huge masses. These are the icebergs; the largest are from the solid middle of the glacier, which in spite of its greater speed, always ends in a concave arch. The flanks that drag on the rocks are not exposed so much to the action of the water, and therefore "kalve" much less frequently.

During the summer of 1880 the expedition made geological researches and explored Waigatted and Disco Island, the west coast of which had never yet been trodden by a European. In several places pure iron was found in the organic basalt. Everywhere on the coast, even on the highest mountain tops, abundant evidence was found that the ice had once covered all in a solid mass—one huge glacier. Erratic bowlders were scattered about, and on the top of the mountain Jonarsnak, 1,634 feet above the sea, the characteristic grooves worn in the rock by glaciers were distinctly recognized.—*N. Y. Tribune.*

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